THE MAINTENANCE OF SOIL FERTILITY

THIRTY YEARS' WORK WITH MANURE AND FERTILIZERS

OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., JUNE, 1924

BULLETIN 381

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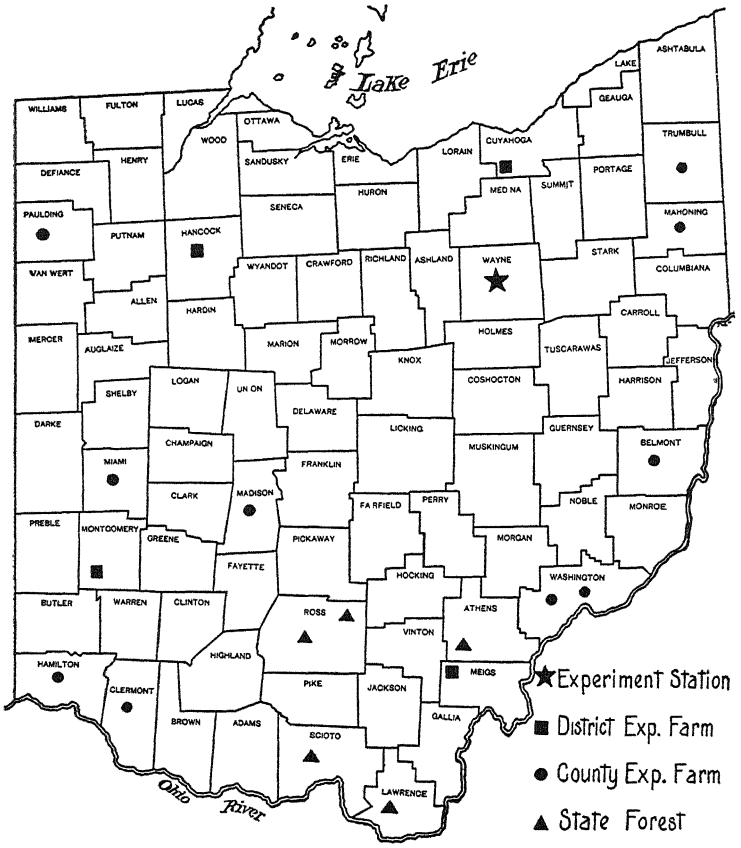
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BULLETIN
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Ohio Agricultural Experiment Station
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THE MAINTENANCE OF SOIL FERTILITY

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PLANS AND SUMMARY TABLES

OF THE FIELD EXPERIMENTS AT THE CENTRAL FARMS, WOOSTER, AND THE DISTRICT EXPERIMENT FARMS AT STRONGSVILLE, GERMANTOWN, CARPENTER, AND FINDLAY

ANNOUNCEMENT

The experiments reported in the following pages were begun in 1893, immediately after the removal of the Experiment Station to Wooster, Wayne County. The general plan of the work at Wooster and Strongsville, and the results attained up to the time of that publication were published in Bulletin 110, issued in December, 1899, and again in Bulletins 182, 183, and 184, reporting to the end of 1906. These publications were followed until 1913 by annual statements, giving as briefly as possible the new data from each successive crop, and referring the reader to Bulletins 182 and 183 for more complete information respecting the nature of the soils under experiment and the general plan of the work, and to Bulletin 184 for the statistics of crop yields for the years 1894 to 1906, inclusive.

The results at Wooster for 1907 to 1913, inclusive, are given in Circulars 83, 92, 104, 114, 120, 131, and 144, No. 144 giving the averages for 20 years and for four five-year periods.

Bulletin 336 gives the average outcome at Wooster for 25 years and by 5-year and 6-year periods, and at Strongsville, Germantown, Carpenter, and Findlay from the beginning of those tests to 1919.

The present bulletin carries the report on these experiments to 1923.

In addition to the work described in this bulletin similar experiments are in progress on county experiment farms in Paulding, Miami, Hamilton, Clermont, Washington, Belmont, Mahoning,

Trumbull, and Madison Counties. These are reported in Bulletins 241, 256, 258, 272, 273, 274, 275, 286, 303, 323, 344, and 361.

In the planning and general supervision of these experiments J. Fremont Hickman was associated with the Director of the Station until the former's death in 1902. Since then C. G. Williams has carried the work forward. For 25 years William Holmes, farm manager, was responsible for the field operations connected with the work at Wooster, assisted by C. H. Lebold and C. A. Patton as assistant foremen. W. J. Green conducted the experiments with potatoes thruout the first 25 years of the test, assisted during recent years by Ora Flack, foreman. The field work at Strongsville was conducted for about 20 years by Edward Mohn. That at Germantown has been in charge of Henry M. Wachter since its beginning, and that at Carpenter was conducted by Lewis Schultz until 1917. J. A. Sutton has been in charge of the work at Findlay from the beginning. Since 1915 the work on all the outlying farms has been conducted under the general supervision of Cary W. Montgomery, chief of the Department of Farm Management.

THE SOILS UNDER EXPERIMENT

The surface rocks underlying the farm on which the Wooster experiments are located, and also a large part of the eastern half of Ohio, are the sandstones and shales of the Waverly geological formation. At the Experiment Station and for a considerable distance southward the soil has been modified by glacial action, but as the movement of the glacier was generally parallel to the lines of rock outcrop the resultant soil has been derived chiefly from rocks similar in composition to those upon which the soil now rests.

The soil in the vicinity of the Experiment Station has been classed as Wooster silt loam; it resembles Volusia silt loam, but is better drained than most Volusia soils because of the more open character of the floor upon which it lies. It is medium in texture between a clay loam and a sandy loam, is easily worked and responsive to treatment and when first brought under cultivation produces good crops. It is, however, relatively deficient both in phosphorus and lime and under the exhaustive system of husbandry which has prevailed it has become so reduced in both elements that additions must be made before profitable crops can be grown.

The Strongsville soil is a brownish-gray, silty clay loam, classed as Trumbull clay loam, a member of the Volusia series. It is a much heavier and colder soil than that of the Wooster farms and is less responsive to treatment. It lies over an argillaceous

shale of the lower Waverly series. Both the Wooster and Strongsville soils have been somewhat modified by glaciation, but the underlying rocks have been the chief factor in their formation.

The Germantown soil is a silty clay loam of the Miami series, lying over glacial gravels largely derived from limestones.

The Carpenter soil is a typical Dekalb silt loam, formed by the decomposition of the underlying sandstones and shales of the barren coal measures.

The soil at Findlay is a Miami silt loam or clay loam derived chiefly from limestones and limestone gravels modified by glaciation.

All the land in these experiments had been in cultivation for many years before the experiments were begun, except a part of that in the potato rotation at Wooster, which was cleared from the forest for the purposes of this experiment; that at Strongsville, which had been in pasture for 25 years or longer; and that at Findlay, which had been used as a fairground.

All the land has been drained with tile drains laid 30 inches deep and 36 feet apart, except the new land in the potato rotation.

CALCULATION OF INCREASE

In calculating the increase in the following tables, it is assumed that variations in the soil are progressive and that if the yields on Plots 1 and 4 were 6 and 9 bushels, respectively, Plots 2 and 3 should have yielded 7 and 8 bushels, respectively, if left unfertilized. While, of course, this regular variation will not always occur, experience has shown that in general this method of computation most nearly approximates the true result.

PRICES USED IN CALCULATIONS

The following prices are used in the computations in this bulletin, unless otherwise stated:

Corn 70 cents a bushel, oats 40 cents, wheat $1, stover and straw $5 a ton, hay $15, tobacco 5 cents a pound, acid phosphate (14 percent) $20, muriate of potash $50, nitrate of soda $70, raw phosphate rock $15, manure $1, ground limestone $5, coarse limestone $3.50, quicklime $12, airslaked lime, hydrated lime, and gypsum $10.

The fertilizer prices are equivalent to 7 cents a pound for phosphoric acid, 5 cents for potash, and 23 cents for nitrogen, or 19 cents for ammonia.

THE WOOSTER EXPERIMENTS

I: FERTILIZERS AND MANURE ON CROPS GROWN CONTINUOUSLY ON THE SAME LAND

Corn, oats, and wheat, one acre (10 plots) each, have been grown in this experiment since 1894. The fertilizers are applied to Plots 2 and 8 in arbitrary quantities, while on Plots 3 and 9 the three fertilizing elements—nitrogen, phosphorus, and potassium—are given in approximately the same ratio to each other in which they are found in the plant.

The applications to Plots 2 and 8 have in every case produced larger average yields than those to Plots 3 and 9; but this may be accounted for in part by the combined nitrogen which is carried to the soil in rain, thus enabling the crops grown on 2 and 8 to utilize larger quantities of the phosphorus and potassium given in the fertilizer than that required merely to balance the fertilizer nitrogen.

The manure applications on Plots 5 and 6 were intended to carry nitrogen in quantities equivalent to the applications on Plots 2 and 3 on the one hand and 8 and 9 on the other, estimating the manure to carry 10 pounds of nitrogen per ton; but actual analyses of manure made during recent years indicate that this estimate was too high for open yard manure, such as is used in these tests.

In this test the corn and wheat show a rapid falling off in yield on the unfertilized land during the first 15 years of the test. Since then there has been comparatively little change. The yield of oats has dimished more slowly than that of the other crops.

The plan of fertilizing in this experiment, and the annual yields per acre by 5-year averages and for the entire period of 30 years are shown in Table 20, pages 296, 297, and 298.

The outcome of this experiment in continuous cropping might be indicated by calculating a balance sheet of the fertilizing elements given to the crops and recovered in their increase. A simpler method is to compute the cost of treatment, the value of the increase, and the percentage which this value is of the cost of treatment, as is done in Table 1.

Analyses by Ames and his co-workers, made since these experiments were begun, indicate that cattle manure, after some months exposure in an open barnyard, should contain per ton about 7½ pounds of nitrogen, 5 pounds of phosphoric acid, and 4 pounds of potash—a lower composition than was assumed in planning the experiment. On the basis of these analyses it would cost about

$2.20 to replace the nitrogen, phosphoric acid, and potash carried in a ton of manure, and this valuation of manure is used in the present comparison.

The table shows that it is necessary to accept this low estimate of the composition of the manure used in this experiment, and that no credit can be given the manure for any other value than that of the nitrogen and mineral elements contained.

The manure used is believed to have fairly represented the manure of the average open barnyard, and it would seem that in this long continued test, in which everything but the roots and stubble of the crops has been removed from the land for 30 successive seasons, the manure would have every opportunity to display its full effect.

TABLE 1.—Crops grown in continuous culture—Cost of treatment, value of increase, and relation of increase to cost

Plot	Corn			Oats			Wheat		
	Cost of treatment	Value of increase	Percent of cost	Cost of treatment	Value of increase	Percent of cost	Cost of treatment	Value of increase	Percent of cost
No.	*Dollars*	*Dollars*	*Percent*	*Dollars*	*Dollars*	*Percent*	*Dollars*	*Dollars*	*Percent*
2	9.70	17.42	180	9.70	10.94	113	9.70	15.68	162
3	6.95	12.81	184	7.40	8.55	115	6.50	9.71	150
5	5.50	9.39	171	5.50	4.25	77	5.50	8.51	155
6	11.00	17.37	158	11.00	8.43	77	11.00	14.80	135
8	15.30	25.85	169	15.30	14.07	92	15.30	20.43	134
9	13.90	24.04	173	14.80	12.74	86	13.00	17.73	136

Continuous vs. rotative cropping.—In contrast with this continuous cropping the same crops have followed each other in succession and have been followed by two years of clover and timothy in a 5-year rotation of corn, oats, wheat, clover, and timothy, each crop being grown every year and the soil being as nearly identical in nature and previous history with that in the continuous cropping as it was possible to select. In both tests half the land has been limed since 1900. When left without any other amelioration than this partial liming, and the recuperation in clover and timothy for two years out of every five, the rotated crops have averaged per acre 26.4 bushels of corn, 31.3 bushels of oats and 11.2 bushels of wheat for the 30 years, or 23.6 bushels of corn, 27.7 bushels of oats, and 10.1 bushels of wheat for the last 5 years, gains over the continuously grown crops of 13.5 bushels of corn, 10.7 bushels of oats, and 4.0 bushels of wheat for the 30 years, or of 14.5 bushels of corn, 13.4 bushels of oats and 5.1 bushels of wheat for the last 5 years.

The largest yields in the continuous cropping, and in the average of the three crops the most profitable yields—those on Plot 8—

have followed a dressing for each crop of 160 pounds acid phosphate, 100 pounds muriate of potash, and 320 pounds of nitrate of soda, carrying 50 pounds nitrogen, 22.5 pounds phosphoric acid, and 50 pounds potash—or about what would be carried in 5 tons of farm manure at the usual estimate of 10 pounds each of nitrogen and potash and 5 pounds phosphoric acid per ton of manure. The cost of the chemicals used on Plot 8 would be $15.30, at the prices here employed—$11.20 for the nitrogen, $1.60 for the phosphoric acid and $2.50 for the potash—and the value of the total yield produced, in excess of the cost of the fertilizer, and including grain and stover or straw, has been $20.89 for the corn, or $9.55 for the oats, or $14.58 for the wheat. In the rotative cropping Plot 11 receives in the same chemicals the equivalent of 15 pounds nitrogen annually, 9 pounds phosphoric acid, and 26 pounds potash, the cost being $5.30, and the outcome has been an annual value of total produce in excess of this cost of $23.76.

This outcome suggests that while with crops of low acre-value rotation with legumes is essential to the most profitable management, yet there may be crops of still higher acre-value than corn, such as truck crops and orchards, with which it may be advisable to practice continuous cropping and make up the nitrogen requirement by larger purchases of fertilizer nitrogen.

II: THE 5-YEAR ROTATION AT WOOSTER

In this experiment corn, oats, wheat, clover, and timothy are grown in succession on five tracts or "sections" of land, A, B, C, D, and E, containing 30 one-tenth acre plots each. Sections A and B of this test lie in Range VIII, south of the areas devoted to continuous cropping, while Sections C, D, and E occupy Range IX, near the east side of the farm.

The land was underdrained in 1893 and corn was grown that season on Section C. The planting was delayed by the draining and the season proved unfavorable, so that the results of that season's work have not been included in the average. In 1894 wheat was harvested on Section A, oats on Section C, and corn on Section D. The clover and timothy followed the wheat on Section A in 1895 and 1896, and the rotation has since been regularly followed.

In 1895 and 1896, and again in 1899, 1900, and 1901, the wheat in this test was injured by hessian fly, the yield on the unfertilized land falling to a small fraction more than 1 bushel per acre in 1896 and 1900. The wheat was again injured by hessian fly in 1911, and also by joint worm. In 1912 these pests again prevailed, and in

addition the winter conditions were such as to cause a partial to complete destruction of the wheat crop over the major portion of the State, the level lands of western Ohio suffering the most severely. The corn in this experiment was severely injured by white grubs in 1910 and 1912, the injury in 1912 being so great that no comparisons could be made.

The clover seeding failed to catch in 1904 and soybeans were grown instead and harvested as hay, the timothy crop of the following year being replaced by German millet. The timothy failed in 1909 and 1915, as did the millet sown in its place, so that no crop of either was harvested in those seasons.

EFFECT OF LIMING

At the time these experiments were planned the deficiency of the soil in lime had not been detected, as clover had been growing luxuriantly when other fertilizing elements were furnished; but within a few years the clover crops began to fail and in 1900 the experiment was begun of liming half the land as it was being prepared for corn, quicklime being applied to the west ends of the plots, fertilized and unfertilized alike. The liming was begun on Section E and was continued on the west ends as the other four sections came under corn. Then it was transferred to the east ends in order to make sure that the differences observed were not due to variations in the soil. By the time Sections E, B, and A had been limed on the east ends this point was thoroly settled, and the liming was returned to the west ends and has been continued on those ends since. The three sections that have had one liming on the east ends, however, still show the effect of that treatment, and the differences between the two ends on those sections are much smaller than on Sections C and D, which have never been limed on the east ends. The average outcome, therefore, shows a smaller effect from the liming than that which has actually resulted.

Beginning with 1900, the corn yields on the limed and unlimed land have been harvested separately to date. The oats crops of 1902, 1903, and 1904 were not harvested separately. The wheat and timothy crops were not harvested separately until 1906, but the clover crops have been harvested separately since they first came under the effect of the liming in 1903.

For these reasons the yields on limed and unlimed land before 1904 are not given separately in the accompanying tables. The plan of fertilizing in this experiment is shown on page 299.

Tables 21 to 28 give, for six 5-year periods and in the average for 30 years, the yields on the east ends of the plots, which have had no lime, except the one dressing on part of the land above mentioned. They also give for four 5-year periods the yields on the west ends of the plots since 1904.

The average increases from liming and the percentage which these increases constitute of the otherwise unfertilized yields are given in Table 2.

TABLE 2.—Average annual increases from liming by 5-year periods—Bushels or pounds per acre

Crop	1904-08		1909-13		1914-18		1919-23	
	Bu. or lb.	Percent	Bu. or lb.	Percent	Bu. or lb.	Percent	Bu. or lb.	Percent
Corn	7.94	29	7.74	46	6.65	31	14.82	91
Oats	2.02	6	1.67	6	10.04	28	10.73	48
Wheat	1.66	13	2.29	22	5.29	45	5.82	80
Clover	566	32	263	19	700	109	1,270	142
Timothy	609	23	486	20	1,054	62	1,140	61
Average	.....	21	.....	23	.....	55	.....	84

Clover has shown the largest relative effect from liming, corn next, and oats least, altho there has been some variation in different periods. The general effect has steadily increased from period to period, the average increase produced by liming having amounted to more than four-fifths of the unaided yield of the land during the last 5 years of the 20-year period.

The average increases from the fertilizers and manure on the unlimed and limed land, are brought together for comparison in Table 3.

TABLE 3.—Average annual increases from fertilizers and manure on limed and unlimed land—Bushels or pounds per acre

Crop	1904-08		1909-13		1914-18		1919-23	
	Unlimed	Limed	Unlimed	Limed	Unlimed	Limed	Unlimed	Limed
Corn.....Bu.	17.94	17.33	17.43	17.02	17.19	17.93	20.48	21.46
Oats.....Bu.	13.46	12.39	14.92	14.36	18.06	13.19	16.86	9.41
Wheat.....Bu.	13.02	13.25	10.65	10.15	14.50	12.88	11.71	11.69
Clover.....Lb.	1,331	1,594	925	1,193	943	959	972	1,042
Timothy.....Lb.	915	1,146	589	898	697	838	809	875

As measured in bushels or pounds per acre the differences between the gains on the unlimed and limed land have not generally been significant for the grains, except during the last two periods

for the oats. The clover and timothy have shown larger gains on the limed land.

In Table 4 are shown the combined increases from liming and fertilizing and the percentage which these increases constitute of the yields of the unlimed and unfertilized land.

TABLE 4.—Total annual increases from liming and fertilizing

Crop	1904-08		1909-13		1914-18		1919-23	
	Bu. or lb.	Percent	Bu. or lb.	Percent	Bu. or lb.	Percent	Bu. or lb.	Percent
Corn	25.27	93	24.84	151	24.58	115	35.46	122
Oats	14.41	43	16.03	63	23.23	66	20.14	89
Wheat	14.91	117	12.44	122	18.17	156	17.53	242
Clover	2,160	124	1,456	106	1,659	260	2,322	260
Timothy	1,745	65	1,384	57	1,892	112	2,015	110
Average	.....	88	.....	100	.....	142	.....	164

This table means that if the unaided yield of the land for each 5-year period be taken as 100, the fertilizing or manuring and liming has increased the total annual produce for the 5-year period, 1904-08 to 188, for 1909-13 to 200, for 1914-18 to 242, and for 1919-23 to 264.

It is true that this computation does not make any allowance for depreciation in the unaided yield of the land. If we take 100 for each crop as that yield for 1904-08 the yields for subsequent 5-year periods would be as shown in Table 5.

TABLE 5.—Showing the relative unfertilized yields of the different crops during 5-year periods as compared with 100 for 1904-08

Crop	1904-08		1909-13		1914-18		1919-23	
	Unlimed	Limed	Unlimed	Limed	Unlimed	Limed	Unlimed	Limed
Corn	100	100	61	69	78	80	60	88
Oats	100	100	76	77	105	127	68	94
Wheat	100	100	79	86	91	116	57	90
Clover	100	100	79	71	37	59	51	94
Timothy	100	100	91	88	63	83	68	90
Average	100	100	77	78	75	93	61	91

Table 5 shows that seasonal conditions play so large a part in crop production that 5 years is too short a period by which to measure definitely a tendency towards increase or decrease, but it seems evident that yields are being much better maintained on the limed than on the unlimed land.

FINANCIAL OUTCOME

In order to show the comparative total effect on the entire rotation of the different treatments in an experiment of this character it is necessary to reduce the crops to a common denominator, either by taking the total weight of produce or by computing its market value. The objection to the first method is that it gives equal importance to the less valuable portions of the produce, while the variation of prices from year to year and in various sections is an objection to the second method. On the whole, however, the second seems to be the preferable method, as it furnishes a basis upon which the difference between cost of treatment and value of increase may be more easily computed than does the first method.

Table 26, constructed by using prices as stated on page 247, gives the average value for the limed and unlimed land for the 20 years, 1904-1923, omitting the first 10 years, altho these are given separately for comparison.

It costs no more to plant and cultivate for a large yield than for a small one, but it does cost a little more to harvest and market the larger crop. No attempt has been made to compute this cost, as it will vary on different farms. The rental value of the land should also be considered. If, for example, the rent per acre is the same whether the yield be large or small, as where the farmer owns the land, the rental cost per bushel or ton will be less for the larger crop than for the smaller one.

High prices for produce afford a wider margin to cover cost of fertilizers than low prices. The most that these comparisons can do, therefore, is to furnish the farmer an approximation to the probable average outcome, and a basis upon which he may compute the outcome for his own market conditions.

Table 29 shows that in the average of all the treatments with fertilizers and manure there was an annual total gain on the unlimed land of $5.43 per acre for the first 5-year period, $8.92 for the second, and an average of $10.44 for the next 4 periods, the variation from this average being less than 10 percent. Liming increased the total gain to a 20-year average of $15.74, an annual gain of $5.30, or $26.55 for each 5-year period to pay for 2 tons of ground limestone.

Considering the fertilizer treatments, it appears that acid phosphate used alone in quantity equivalent to 64 pounds of the 14-percent grade every year, increased the annual produce by $2.61 during the first period, $5.45 during the second, and $7.02 during the third, after which its effect has diminished, the average for the

20 years, 1904-1923, being $5.35. When reinforced with limestone, however, the combined effect has increased from $10.84 for 1904-08 to $12.20 for 1918-23, the combined effect being practically the sum of the two separate effects.

The increases from muriate of potash and nitrate of soda, when used alone or in combination with each other only, have given smaller margins over the cost of the fertilizer than that from acid phosphate alone; but when either or both of these are combined with acid phosphate the net balance has been larger than that from the phosphate used alone, notwithstanding the greatly increased cost of the fertilizers.

The addition of limestone still further increases the net balance. When the land is limed the net increase is almost as great from the combination of phosphate and potash as from the much more expensive combination of nitrogen, phosphate, and potash, showing that the liming has to a considerable degree rendered the addition of nitrogen to the fertilizer unnecessary.

The reduction of the cost of fertilizing by omitting the fertilizer for the oats crop on Plot 14 and for both corn and oats on Plot 15 has reduced the net balance—Plot 11 with its more expensive treatment giving a larger balance after paying for the fertilizer than 14, and 14 larger than 15.

The reduction of the nitrate of soda and increase of the acid phosphate on Plot 17 has only slightly lowered the total increase, while the lower cost of the fertilizer leaves a larger balance.

Computing manure at $1 a ton, the dressing of 16 tons on Plot 18 has given a larger net balance than any other treatment; but if the cost of this manure were computed on the basis of the chemical elements contained, it would amount to more than $2 a ton, not counting the larger cost of its application, thus raising the annual cost on Plot 18 to about $7, and leaving a net balance approximating that found on Plot 17. Here again the more liberal treatment has given the larger net balance, as shown by comparing Plots 18 and 20.

Carriers of Nitrogen.—Plots 17, 21, 23, 24, and 30 have received only half the quantity of nitrogen given to Plot 11 since the beginning of the test, and Plot 27 since 1910, but with an increase of 50 percent in the phosphate, the potash salt remaining unchanged, the object being to compare different carriers of nitrogen in the presence of a relatively abundant supply of phosphorus and potassium. The outcome of this comparison, for the 20 years since liming was begun, is brought together in Table 6.

TABLE 6.—Effect of fertilizers containing different carriers of nitrogen 20-year average annual value of increase per acre

Plot	Nitrogen carriers	Unlimed land	Limed land*
17	Nitrate of soda	$13.85	$14.73
21	Linseed oilmeal	12.12	13.01
23	Dried blood	11.58	13.00
24	Sulphate of ammonia	11.05	13.80
27	Nitrate of lime	11.59	12.14
30	Tankage	13.14	10.93

*In excess of the increase for liming.

Nitrate of soda has given the largest increase on both unlimed and limed land. On the unlimed land tankage comes second. Sulphate of ammonia gives the smallest gain, and in fact clover has practically ceased to grow on the unlimed land receiving this carrier of nitrogen, the small amount of hay reported in Table 7 for 1919-1923 consisting chiefly of weeds. The failure of clover involves a general reduction in the other crops of the rotation. The condition reached by the different crops during the last 5 years of the 20-year period is shown in Table 7, which gives the average annual yields on limed and unlimed land for this period.

TABLE 7.—Average annual yields from fertilizers containing different carriers of nitrogen, 1919-1923

Plot No.	Clover Lb.	Timothy Lb.	Corn Bu.	Oats Bu.	Wheat Bu.
			Unlimed land		
17	1,984	2,962	49.56	50.69	21.37
21	1,761	2,624	42.51	47.84	20.15
23	1,714	2,546	40.90	46.84	19.55
24	1,424	2,585	37.53	46.87	19.85
27	1,869	2,603	42.27	45.50	19.77
30	2,358	3,559	41.41	40.09	20.22
			Limed land		
17	3,680	4,135	59.59	48.31	27.90
21	3,446	4,029	57.26	47.47	26.92
23	3,435	3,918	58.23	48.72	27.50
24	3,584	4,085	61.25	45.62	28.78
27	3,687	4,195	57.09	46.81	26.45
30	3,404	3,932	48.67	42.84	24.87

From the soil-fertility standpoint clover is the most important crop in the rotation, hence it is placed at the head of Table 7, in order the more easily to trace its influence. The weight given in the table for clover on the unlimed end of Plot 24 does not tell the true story, as a much larger proportion of this weight has consisted of weeds than after the other treatments. Next to clover, corn has suffered most from the sulphate, the yield dropping 12 bushels, or about 25 percent, below that after nitrate of soda. The low yield

of oats on Plot 30 is in part due to the fact that this plot was not fertilized in 1921, 1922, and 1923. The yields of clover and timothy on this plot have been higher than on any other unlimed plot in this series. On the limed land the differences in the effect of the nitrogen carriers are insignificant. Corn and wheat show slightly larger yields after sulphate of ammonia than after any other carrier. It appears, therefore, that sulphate of ammonia should only be used on land that is well supplied with lime, but that on such land its effect may be practically equal to that of nitrate of soda, pound for pound of nitrogen carried.

The carriers of "organic" nitrogen—oilmeal, dried blood, and tankage—appear to be generally less effective than nitrate of soda, and thus far nitrate of lime seems to rank with these carriers.

Carriers of phosphorus.—Plots 11, 26, and 29 receive the same quantities of each of the fertilizing elements, but the phosphorus is given in acid phosphate on Plot 11, in steamed bonemeal on Plot 26, and in basic slag on Plot 29. The outcome is shown in Table 8.

TABLE 8.—**Effect of fertilizers containing different carriers of phosphorus 20-year average annual value of increase per acre**

Plot No.	Phosphorus carrier	Unlimed land	Limed land*
11	Acid Phosphate	$14.32	$14.06*
26	Steamed bonemeal	11.82	11.52
29	Basic slag	13.86	11.00

*In excess of increase for lime.

Table 8 gives the effect of fertilizers alone, separate from that of lime, and shows a comparatively insignificant difference between this effect on unlimed and limed land, except where basic slag is used. On limed land basic slag and bonemeal produce nearly the same effect, but on unlimed land basic slag compares with acid phosphate. The inference seems to be justified that the phosphates in basic slag and steamed bonemeal are of practically equal effectiveness, but that for acid soils the lime in basic slag is necesary to bring up its effectiveness to that of acid phosphate.

III: THE LIME AND FLOATS TEST AT WOOSTER

Table 30 gives the average yields and increase to 1923 of an experiment, begun at Wooster in 1905, in a 3-year rotation of corn, oats and clover, for the purpose of comparing the effect of different forms of lime and of obtaining further experience in the use of untreated phosphate rock.

The land had been under the regular rotative cropping of the farm since its occupation by the Station, and for a considerable period before, and was in good condition. Twelve tons of manure per acre had been plowed under for corn in 1904. Three sections of 26 plots each are included in the test, the plots containing one-twentieth acre each.

For the crops of 1905 Section A (north end) was manured at the rate of 6 tons per acre only, because of the recent application above mentioned, and then was limed and fertilized and planted in corn. Section B was sown to soybeans instead of clover, the beans being followed by rye in the fall and corn in 1906. Section C (south end) was limed and fertilized without manure and sown to oats and clover. Thenceforth the manure, lime and fertilizers have all been applied to the corn crops, the manure being plowed under and the lime and fertilizers applied on the surface. The oats and clover receive no treatment.

The clover seeding failed in 1906, 1908, and 1909, and soybeans were grown instead and harvested as hay. During recent years the clover has been more and more largely replaced with sorrel and other weeds on the unlimed land, and in 1921 and 1922 white sweet clover (*Melilotus alba*) was sown in the place of the medium red clover that previously had been used, with the result that no hay was harvested on any of the unlimed land, not even on Plots 11 and 12, receiving manure with gypsum or raw phosphate rock altho wherever lime was used good yields were obtained .

The financial outcome of these treatments would not be exactly the same on any two farms, but as an approximate comparison, figured at the prices stated on page 247, the results for a 3-year period will be as shown in Table 30.

The table shows that, on the basis of the prices used, the dressing of quicklime on manured land has increased the yield practically in proportion to the amount of lime used, the balance over cost of treatment being practically the same for the three quantities of lime. The "airslaked" lime has had nearly the same effect as quicklime; the 1,780 pounds of ground limestone appears to be fully equivalent to 1,000 pounds of quicklime and the 1,320 pounds of hydrated lime a little superior. It seems probable, however, that these quantities of lime are larger than it is necessary to apply so frequently as every third season, and that less frequent application would satisfy the requirements of this soil.

Neither gypsum nor floats is taking the place of lime. Gypsum appears to produce no increase and floats has given less

increase than either lime or limestone. It is remarkable that the sweet clover has failed almost as completely after these dressings and on the manured but unlimed land as where no treatment of any kind has been given.

On the unmanured land quicklime used alone has given considerably larger increase than ground limestone alone, but it is evident that lime does not take the place of phosphorus and potassium.

If we assume that each constituent of the treatment should have the same proportionate effect when used in combination as when used alone the outcome would be approximately as shown in Table 9.

TABLE 9.—Productive effect of separate constituents of treatment

Plot No.	Treatment	Total value of increase	Value of increase due to—				
			Floats	Acid phos-phate	Muriate of potash	Lime	Manure
23	Floats alone	$ 7.33	$7.33				
20	Acid phosphate alone	9.72		$9.72			
10	Lime alone	19.66				$19.66	
26	Manure alone	26.40					$26.40
24	Floats and muriate potash	11.79	7.33		$4.46		
21	Acid phos. and mur. potash	16.33		9.72	6.61		
18	Lime, floats, mur. potash	29.12	6.78		4.14	18.20	
17	Lime, acid phos., mur. potash	36.71		9.80	6.71	20.20	
*	Lime and manure	37.45				16.10	21.34

*Average of treatments 2 to 9.

Table 9 shows that the combination of lime, acid phosphate and muriate of potash has given a larger relative increase than any other treatmnet, while the substitution of floats for acid phosphate has reduced the effect. The combination of lime and manure is less effective than the sum of the separate treatments, which may be due to the fact that manure carries a little lime.

The combination of lime, acid phosphate, and muriate of potash—a combination containing no "organic matter", has produced nearly as large an increase as the combination of the same quantity of lime with manure, and leaves a larger balance unless manure be valued at less than $1.00 per ton. Apparently the larger growth of roots and stubble produced by the more liberal supply of the mineral elements has provided the conditions essential to bacterial action.

Under ordinary farm conditions manure may be saved and spread on the land for much less than one dollar a ton, but when its cost materially exceeds this amount it would seem to be well to consider the use of chemicals.

IV: SUPPLEMENTAL LIMING TESTS AT WOOSTER

In 1915 an experiment was begun in the use of lime in a 4-year rotation of corn, oats, wheat, and clover, each crop being grown every year, the object being to compare the effect of different quantities and different fineness of grinding of limestone; of raw limestone with burnt (hydrated) lime; and of application to different crops in the rotation. The plan of this experiment and the results for the average of the first 9 years are given in Table 31.

The "fine" limestone used in this test is the product of the State Penitentiary at Columbus, a stone analyzing about 85 percent calcium carbonate and 5 percent magnesium carbonate, 35 to 45 percent of which passes thru a sieve having 100 meshes to the linear inch and all thru one having 10 meshes to the inch. This has also been used for the "non magnesian" limestone on Plot 17.

The coarse limestone is the grade known as screenings, all of which passes thru a quarter-inch sieve.

The "magnesian" stone is a dolomite from western Ohio, analyzing about 54 percent calcium carbonate and 43 percent magnesium carbonate.

The non-magnesian hydrated lime has contained about 66 percent calcium oxide and 1.4 percent magnesium oxide, and the magnesian hydrated lime about 45 percent calcium oxide and 32 percent magnesium oxide.

The lime carriers are analyzed each year and are applied to the land in such quantities as to give the same total neutralizing material to each plot, so that the magnesian lime or limestone is used in smaller relative quantity than the non-magnesian.

The entire land, both limed and unlimed, receives a basic dressing of 8 tons per acre of farm manure on corn and 320 pounds of acid phosphate on wheat.

Computing the values of the crops at the prices given on page 247, the outcome of this work is as summarized in Table 10.

TABLE 10.—Supplemental liming tests. Summary

Plots	Treatment	Total value of increase	Cost of liming	Balance
9	Coarse limestone, 2 tons per acre.....	$13.97	$ 7.00	$ 6.97
11	Coarse limestone, 4 tons per acre.....	21.61	14.00	7.61
12	Fine limestone, 4 tons per acre	26.09	20.00	6.09
2-14-17	Fine limestone, 2 tons per acre	21.06	10.00	11.06
15-18	Hydrated lime, 1½ tons per acre.....	23.79	15.00	8.79

On the basis of the prices here employed the 2 tons of fine limestone is giving the most profitable return.

V: SUPPLEMENTAL FERTILITY TESTS AT WOOSTER

In 1915 a new rotation was begun on land since annexed to the original Station farm at Wooster, having for its object the study of some of the questions that have been raised in the older work.

One question that has frequently been raised by farmers visiting this older work has been whether the same expenditure of money in acid phosphate alone might not have produced a greater net gain than that recovered when the more expensive carriers of nitrogen and potassium were added to the phosphate. Another question has been whether it is better to distribute the fertilizer over all the crops of the rotation, or whether it may as well all be given to a single crop, and if the latter, to which crop. Other questions relate to the ratio between the different elements in the fertilizer; to the relative effectiveness of the elements in manure and chemicals, and to the possibility of replacing the fertilizing materials in ordinary use with other carriers of the essential elements of fertility.

Realizing the impossibility of answering all the questions that suggest themselves, an experiment was begun in 1915, the plan of which is shown on page 321, and the average results in Table 33.

Where mixed fertilizers are used on Plots 5 to 18 the total quantity is brought up to 1,000 pounds by the addition of dry earth, to facilitate distribution and to show uniformity in formulas.

The fertilizers and crops are computed at prices given on page 247. At these prices it would seem, at this stage of the work, to be better to put part of this expenditure for fertilizers into nitrogen and potassium, rather than to put it all in phosphorus.

Thus far, the concentration of the whole application of fertilizers on the wheat crop has been more profitable than to distribute it over the other crops, but this may be partly due to seasonal conditions especially favorable to wheat. The nine crops of wheat thus far grown have averaged 24 bushels per acre on land receiving no fertilizer nor manure, and this yield has been increased to nearly 38 bushels by 1,000 pounds of a 2-8-2 fertilizer; to 35 bushels by 500 pounds each on corn and wheat, and to 34.6 bushels by 332 pounds each on corn, oats, and wheat. The increase in the other crops in the rotation has made the concentration of all the fertilizer on wheat the more profitable method. This is in harmony with the common experience that crops of high acre-value will usually justify larger expenditure for fertilizing than those of low acre-value. It is interesting, however, to note that the same treatment

which has increased the wheat yield by 60 percent of the unfertilized yield (Plot 11), has raised the corn yield by less than 25 percent of the unfertilized yield, while at normal prices a bushel of wheat is worth twice as much as a bushel of corn.

The calcined and duplex basic phosphates are products resulting from attempts to make the phosphorus of phosphate rock available without acidulation. Thus far they have proved considerably less effective in this experiment than acid phosphate, which is also true of the comparison between feldspar potash and the muriate.

Calcium cyanamid (Plot 24) has been less effective than nitrate of soda (Plot 17).

The manure used in this experiment has been taken from a shed in which stock cattle had been kept, and has been used on the assumption that it should contain as much as 11 pounds of ammonia, 4½ pounds of phosphoric acid and 7½ pounds of potash to the ton of manure, but the outcome shows that the manure has thus far produced a considerably smaller increase than chemical fertilizers carrying ammonia, phosphoric acid, and potash, in quantities equivalent to those which would be carried in the manure applications on the basis of these estimates.

The cost and balance from the treatments with manure are as follows:

Plot No.	Treatment per rotation		Annual cost	Balance
29	Shed manure, 4 tons, all on corn		$1.00	$1.44
30	Shed manure, 4 tons Acid phosphate, 480 lb.	All on corn	2.53	3.15
32	Shed manure, 8 tons Acid phosphate, 480 lb.	Half each on corn and wheat	3.53	4.59
33	Shed manure, 8 tons Acid phosphate, 480 lb.	All on corn	3.53	4.59
35	Shed manure, 8 tons Acid phosphate, 480 lb.	All on wheat	3.53	5.68
36	Shed manure, 8 tons Acid phosphate, 480 lb.	All on young clover	3.53	2.58
38	Shed manure, 8 tons Raw phosphate, 768 lb.	All on corn	3.53	0.83
39	Shed manure, 8 tons Acid phopsate, 480 lb. Muriate potash, 120 lb.	All on corn	4.53	1.98

Even at the low valuation for manure, $1 a ton, the fertilizer treatments on Plots 11 and 14 have exceeded in net return the best outcome from manure. It must be remembered, however, that the estimated cost of the chemical fertilizers is based upon the cost of

the unmixed materials. Were they purchased in factory mixtures their cost would run considerably higher and their efficiency would probably be lower.

In the absence of phosphate reinforcement the manure has given a small return. Of the two phosphates, it has been better to purchase acid phosphate than to use raw phosphate at no cost. The reinforcement of shed manure with potash has not been profitable. As in the treatment with chemicals, it has been more profitable to use all the manure on the wheat and less so to use it all on the new seeding of clover than to use it all on corn or to divide it between the wheat and corn. It must be remembered, however, that this manure has been heavily reinforced with phosphorus, to which element wheat is much more responsive than corn.

Of the various chemical treatments, that on Plot 14, receiving a 2-12-2 formula, has given the largest net return, altho the gross return has been practically the same from the 4-12-2 formula on Plot 15 and from the 4-8-8 formula on Plot 18, while the 4-8-4 on Plot 17 and the 4-12-4 on Plot 21 fall but little behind. All these high-analysis fertilizers, except that on Plot 21, give a larger net return than the low grade, 2-8-2 mixture when used under the same conditions, notwithstanding their higher cost.

As the test has worked out, the effect of the treatments in which oats and clover receive part of the fertilizer is not fairly comparable with those in which it is divided between the corn and wheat, because of the lower responsiveness of oats and clover.

VI: THE BARNYARD MANURE TEST

COMPARISON OF YARD WITH FRESH MANURE. THE REINFORCEMENT OF MANURE

This experiment was begun in 1897 for the purpose of comparing manure which has lain for some months in an open barnyard with that taken directly from the stable to the field, and of studying the effect of treating the manure with several absorbent or reinforcing materials. In the earlier years of this investigation a lot of manure was taken from the open barnyard, where it had been accumulating during the winter, and divided into four parcels. With one parcel was mixed the finely ground phosphatic rock, known as floats, from which acid phosphate is made by mixing it with sulphuric acid; with another parcel acid phosphate was mixed; with a third, the crude potash salt, known as kainit, and with a fourth, land plaster or gypsum; the reinforcing materials being used at the uniform rate of 40 pounds per ton of manure. At the

same time manure taken from box stalls, where it had accumulated under the feet of animals kept continuously in their stalls, was divided into similar parcels and treated with like quantities of the same materials.

After a few weeks the manure thus treated, together with two lots of untreated manure, one taken from the yard and one from the stable, was spread upon clover sod at the rate of eight tons per acre and plowed under for corn, the corn being followed by wheat and clover in a 3-year rotation. During the first three seasons soybeans were grown, because of clover failure, and were plowed under.

Because of the uncertainty as to the quantity of fresh manure required to produce a ton of yard manure under these conditions the plan was changed in 1903, and since then a sufficient quantity of fresh manure for the purpose of the experiment is weighed out of the stables in December or January and forked over carefully to secure a uniform product. The manure is then divided into five equal parcels, four of which are treated as above indicated, and the fifth is left untreated. Each parcel is then divided into two equal portions, one of which is immediately spread upon the plots receiving "stall manure", while the other is placed in a flat, compact pile in an open yard, where it remains undisturbed until April, when it is spread on the "yard manure" plots, and the whole is plowed under at the rate of 8 tons of the original manure per acre.

Three tracts of land, A, B, and C, are included in the test, each crop being grown every season. The arrangement of these tracts, the plan of fertilizing, and the results obtained are shown in the diagram and in Tables 34 and 35.

The results of this work are summarized in Table 11, which shows, for the two periods, the values of the total yields and increase per acre, and of the increase per ton of manure.

In 1905 Section B in this test received a dressing of quicklime, applied at the rate of a ton to the acre and spread over all the land, manured and unmanured alike, after the land had been plowed for corn. In 1906 and 1907 Sections A and C were dressed with ground limestone, used at the rate of two tons per acre and likewise spread over all the land after plowing for corn. In 1911 and since ground limestone has been applied to each section as it came under corn.

The corn was so injured by grub worms in 1909 that no comparison could be made, and that crop is omitted from the tables.

It will be observed that the yields on the untreated land, as well as those from every treatment, have been greater during the second

period than during the first, altho the liming has so increased the yields on the unmanured land that the gain for manuring and fertilizing has been smaller in every case except for the untreated yard manure and for the chemicals on Plot 18. This apparently means that the liming has so improved the soil conditions as to make the nitrogen in manure and nitrate of soda more effective.

The computations (see method page 247) show a consistently larger increase from acid phosphate than from floats, altho the total yields are about as large from the floats as from the acid phosphate. In the second period, however, the acid phosphate remains distinctly in the lead, altho the larger quantity of phosphorus applied in the floats had led us to expect that as the floats had longer time in which to become available just the opposite outcome would be realized.

Yard vs. stall manure.—Table 35 gives five comparisons between yard and stall manure, the averages of which are as follows for the two periods:

	Value per ton of manure	
	First period	Second period
Yard manure	$5.52	$5.21
Stall manure	6.88	5.94
Excess for stall manure	1.36	.73

This comparison indicates that the yard manure has gained upon the stall manure in efficiency. In 1918 the yard manure showed greater increase than the stall manure, an outcome probably due to the fact that that winter was exceptionally dry, the rainfall being only two-thirds the normal amount for the period during which the manure was exposed, while the heaviest rainfall of the winter—February 19—found the stall manure spread on frozen ground and probably washed out and carried away a part of its nitrogen. Even at the lower difference, however, the average increase from the acre-dressing of 8 tons has been worth nearly $6 more for the stall manure than for the yard manure.

Acid phosphate vs. raw phosphate, kainit, or gypsum as a reinforcement of manure.—In the average of the yard and stall manure the values of the increases from the reinforced manures have exceeded those from the untreated manures by the amounts per rotation shown in Table 11.

At $20 a ton the 320 pounds of 14 percent acid phosphate used with the acre-dressing of 8 tons of manure would cost $3.20, hence it has been more profitable to use acid phosphate at this cost than to use any of the other materials at no cost during the first period, while during the second period the substitution of any one of the

other materials, even tho it cost nothing, for acid phosphate would have meant a loss of $14 to $19 an acre for each 3-year rotation.

Is it the sulphur in acid phosphate that makes it more useful?—Acid phosphate is made by mixing approximately equal weights of ground raw phosphate rock and sulphuric acid, the product being practically a mixture of the phosphate and sulphate of lime, while gypsum is a natural sulphate of lime. It appears from this experiment that acid phosphate is supplying all the sulphur required by the crops grown and that the use of gypsum in addition is unnecessary.

TABLE 11.—Acid phosphate vs. other materials as a reinforcement of manure

Reinforcement materials	Value of increase from differently treated manures per acre per rotation	
	First period	Second period
None	$37.10	$38.33
Acid phosphate	62.26	58.23
Raw phosphate	55.63	44.31
Kainit	48.73	43.15
Gypsum	44.37	39.17
Increase for acid phosphate	25.16	19.90
Increase for raw phosphate	18.53	5.98
Increase for kainit	11.63	4.82
Increase for gypsum	7.27	0.84

The question has been raised, whether the addition of gypsum to raw phosphate rock might not serve the purpose of acid phosphate. Table 11 shows that the sum of the increases for raw phosphate and gypsum is practically equal to the increase from acid phosphate during the first period, but this is not conclusive evidence that the same result would have followed a mixture of the two. During the second period the sum of these increases is only about one-third the increase from acid phosphate.

In any case the cost of such a mixture is likely to be greater than that of acid phosphate.

Is it necessary to mix the phosphate and manure?—Another question has been raised—namely: whether the separate application of acid phosphate and manure might not serve the same purpose as the mixture. When the experiment was begun it was expected that one of the functions of the acid phosphate would be the conservation of the nitrogen of the manure. Gypsum had previously been used for this purpose. The outcome indicates that both acid phosphate and gypsum may have had this effect to some extent in the earlier years of the test, but the increase in yield after liming was begun, taken in connection with the smaller effect of

both acid phosphate and gypsum, indicates that the systematic liming of the land has contributed more to the fixation and conservation of nitrogen than the use of either acid phosphate or gypsum, and therefore that the phosphate should be used primarily as a carrier of phosphorus. For this purpose it might be better to give the manure to the corn and the phosphate to the following wheat, when it is not practicable to treat both crops with phosphated manure.

VII: THE POTATOES-WHEAT-CLOVER ROTATION

This experiment is located southeast of the orchards, and contains three sections of 34 tenth-acre plots each. The south section (A) and about half of the middle section (B) had been in cultivation for an unknown period before the test began. The north part of Section B and all of the north section (C) were cleared from the forest for the purposes of this test. The old land was tile drained in 1893, and the work was begun by planting Section A to potatoes in 1894. Wheat and clover followed in 1895 and 1896 and the rotation has been maintained regularly since.

The diagram, page 328, shows the arrangement of plots and plan of fertilizing one of the sections in this experiment, the three sections being arranged and treated alike. Tables show the outcome for the 30 years, 1894-1923, and for 15-year periods.

Since 1903 the land in this test has had several dressings of lime or limestone, the liming being done while the land was being prepared for wheat, except in 1905 and 1909, when it was done in the spring. Quicklime was used in 1903, hydrated lime in 1905, and ground limestone since, the last dressing being in 1915. The rate of application has been about equivalent to 2 tons of limestone per acre.

The potato crops have suffered increasingly from disease, the yields being but little more than half as large during the last 15 years as during the first 15 years.

There has been a striking change in the behavior of the potatoes towards phosphoric and potassic fertilizers during the two periods. During the first period the increase from acid phosphate, used alone, averaged nearly 15 bushels per acre, whereas during the second period a decrease of 2 bushels followed the same treatment. During the first period muriate of potash, used alone, increased the yield by 9½ bushels, and during the last period by 23 bushels.

When the acid phosphate and muriate of potash are combined, on Plot 8, the increase is 30.66 bushels for the first period and 38.75

bushels for the last, indicating that the acid phosphate has regained its effectiveness when associated with the potash salt.

It would seem that the potash salt may have enabled the plant to resist disease to some extent. In other tests, however, the same salt has shown greater effect on limed than on unlimed land, and in the present case the effect of this salt has been greater since the liming was begun.

POTATOES AND NITROGEN

Nitrate of soda, whether used alone or in association with acid phosphate or muriate of potash, one or both, has produced a comparatively small increase in the potato crop, and its effect seems to have been smaller during the last period than during the first, the yield during the last period having been practically the same from acid phosphate and muriate of potash alone (Plot 8) as from the same quantities of these with nitrate added (Plot 11). The reduction in the quantity of nitrogen, on Plots 20, 21, 23, and 24 seems to have been favorable to increase in yield of potatoes.

Taken as a whole, the results do not justify the purchase of nitrogen for potatoes when grown after clover that has been maintained in thrifty condition by liming.

The wheat and clover crops have not followed the potatoes in their attitude towards the two fertilizing materials, the wheat showing a larger gain from acid phosphate and a slightly smaller one from muriate of potash during the last period than during the first, and the clover a smaller gain from both materials during the last period.

The addition of 160 pounds of nitrate of soda to the combination of acid phosphate and muriate of potash has increased the yield of wheat by only about a bushel and a half, and in the total outcome for the three crops has reduced the net balance by more than three dollars. When the nitrogen has been reduced to 80 pounds of nitrate or its equivalent, however, the net gain is somewhat increased, altho the total yield is reduced.

Sulphate of ammonia appears to have been a somewhat more effective carrier of nitrogen in this test than nitrate of soda, after the land was limed. Previously, the nitrate gave the larger increase.

Two plots in this test, 12 and 14, have given an average yield for 29 years of more than 38 bushels of wheat to the acre, and two more, 11 and 15, fall but little below this amount, while 9 others have yielded between 35 and 36 bushels. Considering both quantity of yield and duration of test these are among the largest of the world's authenticated yields of wheat.

In 1895 and 1896 the wheat in this test was severely injured by hessian fly, but it escaped the attack of 1899 to 1901. In 1911 there was again some injury from fly and joint worm.

In 1909 the clover failed; attempts were made to grow crimson clover and soybeans in its stead, but there was failure in securing a stand of these crops also, so that it has been necessary to omit the clover for that season from the calculations. In 1905 continuous rains prevented harvesting the clover until very late, and caused the fertilized plots to lodge so that these plots weighed less than those not fertilized, tho earlier in the season they had shown a distinctly larger growth. As there was no way by which the yields could be corrected and as it seemed desirable to include the crop in the general average because of its effect on the average unfertilized yield it has been so included, altho the doing so slightly reduces the apparent average effect from the fertilizers.

THE STRONGSVILLE EXPERIMENTS

The Strongsville farm is situated in southern Cuyahoga County, about 14 miles southwest of the public square in Cleveland. The land upon which this test is located slopes gently to the north, and overlies the argillaceous Cuyahoga shale from which the soil has been chiefly derived. The upper layers of the shale bear evidence of having been deposited as a mud in shallow water at a comparatively recent geologic period. The soil contains a much larger proportion of clay than that at Wooster; hence it is more difficult to work, it dries out more slowly, and suffers more from excess or deficiency of moisture. The native forest growth of this region consists chiefly of beech and elm, with sugar maple on the drier portions. The soil is classed as Trumbull clay loam, a type closely related to the Volusia clay loam, deficient in lime, lying too flat to afford natural drainage and consequently being water-logged until late in the spring. It represents that phase of the soils covering the northeastern counties of the State in which the ameliorations of drainage, liming, and fertilizing are the most essential to successful agriculture.

VIII: THE 5-YEAR ROTATION AT STRONGSVILLE

In 1895 a 5-year rotation was begun on this farm, duplicating the one at Wooster, the object being to study the same methods of treatment on two very dissimilar soils. The arrangement of plots in this test is shown on page 334. The results for the periods since the use of lime and raw phosphate was begun are given in Tables 39, 40, and 41.

Soon after the experiment was begun the land in Sections A, B, C, and D was drained with tile drains laid 30 inches deep and under alternate dividing paths, but Section E was not drained until several years later.

As in the similar experiments at Wooster, no provision for the use of lime was made in the original plan of the test; but in 1901 the experiment was modified by applying lime to the south half of each section as it came under corn, the lime being used at first at the rate of 1 ton of quicklime, and later at 2 tons of ground limestone per acre and spread over all the land after plowing, fertilized and unfertilized alike; and three years later a further modification was made by spreading raw phosphate rock at the rate of 1 ton per acre across the north ends of the plots at the same time and in the same manner that the limestone was spread across the south ends.

The raw phosphate was discontinued in 1913, after the equivalent of 2 tons per acre had been applied, but the liming has been continued on every corn crop to date.

During the first 17 years of this experiment there were nine failures of the timothy crop; the attempt to grow this crop was then abandoned and the soybean, grown for hay, was substituted in the rotation, which was so rearranged as to make the succession corn, oats, soybeans, wheat, and clover. For this reason the timothy is omitted from the computations which follow, and the work is treated as a 5-year rotation of corn, oats, soybean hay, wheat, and clover.

Tables 39 and 40 give the annual yields obtained in this experiment on the four sections, A, B, C, and D during the period 1905-1923, Section E being omitted because of an error in treatment. Table 41 shows the total quantity of fertilizing materials applied during this period, their cost and the total value of the yield and of the increase from fertilizers on limed and floats-treated land.

Effect of liming.—The method of treatment has left no direct comparison of untreated land with that receiving the limestone or phosphate treatment; but if the rate of yield during the first ten years after the experiment was begun in 1895 had been maintained the total value of the crops included in the present computation would have been $860, if grown on untreated land, leaving $230 as the effect of the limestone. In the experiment reported on page 277 of this bulletin, however, the average increase from limestone on this land has had a value of $12 per ton of limestone, at the valuations here employed. Excluding the last application, the full effect of which has not yet been realized, 28 tons of limestone has been

employed in the test under review, the total effect of which, at $12 per ton, would amount to $336. Considering the fact that there would certainly have been some falling off in yield during 15 years further cropping without any treatment, it seems conservative to take this as the probable average value of the increase due to liming. Therefore, in Table 41, the column headed "Assumed unlimed yield" has been computed by subtracting $336 from each of the yields found on the limed land. This subtraction does not affect the computed increase from fertilizers on the limed land, which may be calculated either from the total yield on the limed land or from the assumed unlimed yield.

Effect of raw phosphate.—In computing the increase due to the raw phosphate, the total increase on the phosphate-treated land is calculated from the assumed unlimed and unfertilized yields; and the increase due to the other fertilizers is subtracted from this total, leaving the sums found in the final column of the table.

In considering the results of this computation it must be borne in mind that after a certain quantity of manure or fertilizer has been applied an increase in application will not be followed by a corresponding increase of crop. Thus 116 tons of manure has increased the yield on Plots 20 by $431 on the limed land; while 232 tons, on Plots 18, has raised the increase only to $642.

The tables show that, in the great majority of cases, the land receiving raw phosphate has outyielded that receiving limestone. On the otherwise unfertilized land the excess of the raw phosphate-treated land over that receiving limestone is $368, this amount being in excess of the increase due to the limestone. If we add to this sum the increase estimated as due to the limestone, the total credit to the raw phosphate amounts to $704. As 7 tons of raw phosphate has been applied, this credit amounts to $100 per ton of phosphate. (Section D received raw phosphate in 1905 and 1910; Section A in 1907 and 1912; Section B in 1908 and 1913, and Section C in 1909. None has been applied since 1913.)

On Plot 2 the increase from acid phosphate on the limed land amounts to $585 in excess of the yield produced by liming, on Plot 6 the addition of the same quantity of acid phosphate to the dressing of nitrate of soda given Plot 5 increases the yield over that of Plot 5 by $647; on Plot 8 the same addition increases the yield over that of Plot 3 bf $711; and on Plot 11 the same addition increases the yield over that of Plot 9 by $584. The lowest increase, $584, amounts to $250 per ton of acid phosphate.

The addition of raw phosphate to Plot 3 has increased its yield to $1,252, or to $609 more than the assumed unlimed yield, but $102 less than the yield computed as due to acid phosphate when added to muriate of potash. On Plot 5 the raw phosphate has raised the yield to $1,556, or to $906 above the assumed unlimed yield, as against the $647 ascribed to the effect of acid phosphate when added to nitrate of soda; and on Plot 9 the raw phosphate has raised the yield to $1,967, or to $1,081 more than the assumed unlimed yield, as against the $584 computed as due to acid phosphate on Plot 11.

These inequalities in effect of the two phosphates when compared under the same conditions are in part at least due to inequalities of soil. The limed and phosphated plots stand end to end, instead of side by side, thus rendering an exact comparison impossible. It seems clear, however, that the raw phosphate has produced a large increase when used in connection with nitrate of soda and muriate of potash, one or both. Taking the increase on Plot 9 as the most favorable showing for raw phosphate, it amounts to $155 per ton of phosphate.

It is interesting to consider more in detail the last column of Table 41. On Plot 2 the small additional increase from the raw phosphate over that produced by acid phosphate, without the support of nitrogen or potassium beyond that furnished by the clover is what would be expected. The effect of substituting raw phosphate for acid phosphate on unfertilized land and on land receiving nitrogen or potassium, has been discussed above. On Plots 6, 8, 11, and 12 and again on Plots 32, 33, 35, and 36 the raw phosphate is added to dressings of acid phosphate, muriate of potash, and nitrate of soda, and its computed effect runs fairly close to an average of $531, the deviations from this average being no greater than those shown by the unfertilized yields from their average.

Plot 14 receives the nitrate and potash salts only on corn and wheat, and Plot 15 only on wheat; but all the crops receive the raw phosphate, and these plots show a relatively large return from the phosphate. Plot 38 is also fertilized only on wheat, but it receives a very small allowance of the nitrate and potash salts.

Plots 17, 21, 23, 24, and 30 receive a half-ration of nitrogen, with a ration and a half of acid phosphate, which leaves little room for more phosphorus, as is shown in the lower increase from raw phosphate on these plots. Plot 27 was changed a few years ago to compare with these plots, the dissolved boneblack being

replaced with 480 pounds per rotation of acid phosphate, and a half ration of nitrate of lime being substituted for the previous full ration of nitrate of soda.

Plots 26 and 29 receive their phosphorus in the non-acidulated forms of steamed bonemeal and basic slag. Apparently the raw phosphate has been more effective when associated with acid phosphate.

On the manured plots—18, 20, and 39—the increase from raw phosphate is lower than that from any plot receiving the full ration of nitrate of soda, thus indicating that nitrate nitrogen has been more effective than the organic nitrogen of manure in liberating the phosphorus of the raw phosphate. It will be observed also that Plot 24, receiving its nitrogen in sulphate of ammonia, shows the lowest effectiveness for raw phosphate in the series.

Raw phosphate vs. limestone.—The raw phosphate has not met the demand for lime on this soil. This point has been observed thruout the test, the clover and soybeans being conspicuously more luxuriant in the earlier stages of growth on the limed than on the phosphated land. The greater final weight on the phosphated land has apparently been due to the larger growth of the timothy sown with the clover and of the soybeans during the seed-forming period, the abundant supply of phosphorus enabling those crops to overcome the lime deficiency, to which deficiency neither timothy nor soybeans is so sensitive as clover.

Sweet clover, which is one of the most sensitive plants to lime deficiency, in the test at Wooster, reported on page 258 of this bulletin, is refusing as absolutely to grow on the plot receiving 8 tons of manure and 1,000 pounds of raw phosphate per acre every third season as when no manure nor fertilizer of any kind is applied; yet wherever lime is given, either as burnt lime or ground limestone, there is a luxuriant growth of sweet clover, whether the land has been manured or not.

In this Wooster experiment the values per acre of the increases for each 3-year rotation of corn, oats, and clover have been as follows:

(a)	From lime alone (1,000 pounds)	$19.66
(b)	From acid phosphate (320 lb.) and muriate of potash, (40 lb.)	16.43
(c)	From combination of (a) and (b)	36.71
	Gain for lime	20.28
(d)	From raw phosphate (320 lb.) and muriate of potash (40 lb.)	11.79
(e)	From combination of (a) and (d)	29.21
	Gain for lime	17.42

The combination of acid phosphate, muriate of potash, and lime has been more effective than the separate applications; and that of raw phosphate, muriate of potash, and lime less effective.

At the Clermont County Experiment Farm an experiment has been running for 6 years in which acid phosphate is used at the rate of 520 pounds per acre and raw phosphate at the rate of 1,040 pounds, in a rotation of corn, soybeans, and wheat, with the following outcome:

Treatment	Value of increase per rotation
Acid phosphate and limestone	$22.62
Raw phosphate and limestone	18.25
Acid phosphate, muriate of potash, limestone	31.03
Raw phosphate, muriate of potash, limestone	26.63

The limestone is used at the rate of 2 tons per acre for each rotation and the muriate of potash at the rate of 40 pounds per acre.

In each comparison the increase from acid phosphate has been materially greater than that from twice the weight of raw phosphate.

Comparison of other carriers of phosphorus.—In the comparison of Plots 11, 26, and 29 the increase is materially greater from acid phosphate than from either bonemeal or basic slag.

Comparison of carriers of nitrogen.—The outcome of this comparison is set out below:

Plot	Nitrogen carrier	Total increase over limestone	Total increase over floats
17	Nitrate of soda	$785	$491
21	Linseed oilmeal	755	348
23	Dried blood	638	372
24	Sulphate of ammonia	667	271
30	Tankage	699	352

This table is computed to show the full effect of the fertilizers containing the different nitrogen carriers, exclusive of the effect of limestone and raw phosphate. The lower effect on the phosphated

land is due to the partial obscuring of the effect of the phosphorus by the phosphating of the check plots, and more nearly shows the actual effect of the nitrogen carrier alone, altho in this case also deduction must be made for the effect of the muriate of potash and for part of the phosphorus. What the table does show is that nitrate of soda is more effective than any of the other carriers.

PRACTICAL APPLICATION

The land on which this experiment is located had been in pasture for many years when the experiment was begun. It was wet and soggy and completely occupied with "poverty grass". It was fairly typical of large areas in the northeastern counties of the State. Drainage was imperative; but that alone was insufficient, as shown by the unfertilized yields which averaged but 23.2 bushels of corn, 34.8 bushels of oats, 5.6 bushels of wheat, and 1,369 pounds of clover hay per acre during the first 10 years, or until liming was begun, the crops having an annual acre-value of $13 at the prices herein employed.

Fourteen percent acid phosphate, used at the rate of 80 pounds per acre each on corn and oats and 160 pounds on wheat, increased the annual values to $18; and 16 tons of open-yard manure, 8 tons each on corn and wheat, raised it to $20.

Since liming was begun the yields on the otherwise unfertilized land have had an annual value of $17.12. Acid phosphate, used at the same rate as before, has raised the yield to $23.60, and manure has increased it to $28.40.

It is evident from the increased yields on the land receiving raw phosphate over those on the limed land, that this land is ready to respond profitably to larger applications of phosphorus than those made on the limed land. The only question is as to whether the raw phosphate is a better material to use for this purpose than acid phosphate. The answer is found in the relative cost and effectiveness per ton of the two phosphates, and this answer seems to be decisively in favor of acid phosphate wherever the two have been used under comparable conditions.

This experiment and the one described on page 277 of this bulletin, have demonstrated that the use of lime on this land has become imperative, if full crop yields are to be obtained; and other tests are showing that lime and acid phosphate make a more effective pair than lime and raw phosphate.

Taking the yields on the unfertilized land and on that receiving acid phosphate only during the first 10 years and comparing with

these the yields from a few treatments during the last 15 years, selected because of their practicability, Table 12 has been constructed:

TABLE 12.—Annual yields per acre on Strongsville Experiment Farm (Fractions omitted)

Crop	Treatment and yield per acre						
	None	Limestone only	Acid phosphate only	Limestone acid phosphate	Limestone complete fertilizer*	Limestone and manure†	Phosphate and manure‡
Corn.....bu..	23	26	29	34	45	45	47
Oats..... bu..	35	35	43	45	55	48	52
Wheat.....bu..	6	12	12	22	29	23	25
Hay, clover.....cwt..	14	19	21	30	33	33	43
Hay, soybean.....cwt..	16	23	20	23	33	34	30
Annual value‡..... .....dol..	13	17	18	23	30	28	30
Cost of treatment.....dol..	.....	2	1	3	6	4	4
Balance.....dol..	13	15	17	20	24	24	26

*Plot 17. †Plot 18, limed end. ‡Plot 18, raw phosphate end.
‡Computed on actual yields, including stover and straw.

In this table manure is computed at 60 cents per ton to cover cost of hauling out and spreading. Were the cost materially to exceed this amount a larger use of chemicals would be indicated. But the experiments at Wooster have shown that by the substitution of acid phosphate for raw phosphate in the reinforcement of manure and by preservation of the manure from exposure to the weather until it is spread upon the field a much greater effect may be realized than that shown from such manure as has been used in this test.

The special lime test on this farm, described on page 277, and the investigations at Wooster, indicate that after the land has once been neutralized by a liberal dressing of lime a smaller quantity than that used in this test will be sufficient, provided the limestone is finely ground. If coarser stone is used more will be necessary.

The yields obtained on Plot 17 in this test and the practically equivalent yields recovered from manure on the floats-treated end of Plot 18 are much larger than the average yields of Ohio—enough larger to more than cover all cost of liming and fertilizing. In the light of the results obtained from other combinations of fertilizing materials used in this test it would seem probable that, next to the combination of acid phosphate and sheltered manure, the most effective fertilizer for ordinary cereal crops grown in rotation with clover on this soil would be one made up of about 160 pounds nitrate

of soda or sulphate of ammonia, 800 pounds 16-percent acid phosphate and 40 pounds muriate of potash. This mixture will have approximately a 3-13-2 percentage composition, and should be used at the rate of 300 or more pounds per acre on every cereal crop.

The high cost of low fertilizing.—Plot 38 has had on each wheat crop 210 pounds per acre of a mixture of nitrate of soda, acid phosphate and muriate of potash, equivalent in composition to a 2-8-2 formula. While it has given a considerable increase its use has involved a net loss of more than $200, as compared with the effect of 320 pounds of plain acid phosphate, distributed over the 3 grain crops of the rotation.

CONCLUSIONS

These investigations have shown that in raw phosphate the Ohio farmer would have an incalculable boon, were nothing better to be had, but that acid phosphate is so much more effective, under ordinary farm conditions, as to make the use of raw phosphate unprofitable.

They have also demonstrated the economic practicability of bringing up the yields of this thin, cold soil until they rival those of the best lands in Ohio, and they leave no room to doubt that further studies will lead to still larger yields, produced at a lower cost.

IX: LIMING EXPERIMENTS ON THE STRONGSVILLE FARM

In 1906 an experiment was begun in the use of limestone on land that had lain in pasture for 30 years or longer. It was not practicable to drain the land at the beginning of the experiment, except by the surface drains produced by ridging the plots, but in 1914 it was tile-drained with drains running across the plots. It was arranged in 3 sections of 30 tenth-acre plots each and a 3-year rotation of corn, wheat, and clover was started on the plan shown in Table 42, each crop being grown every year after the rotation was established. Because of the difficulty in getting the corn off the land in time for wheat—a difficulty much greater here than farther south, not only because of the difference in latitude but also because of the cold nature of the soil—the rotation was changed in 1915 to one of corn, oats, and clover.

In Table 43 the average yields of corn are given for 17 years, those of wheat for 5 years, those of oats for 9 years and those of hay for 14 years, the wheat having failed entirely in 1907, 1909, and 1913. No corn was grown in 1908 and the treatment was suspended for that year.

Table 43 shows the entire quantity of fertilizing materials and limestone applied during the 17 years of the experiment, and the value of the total produce and of the increase due to the liming, using the low valuations heretofore employed.

The increase produced by liming has been computed on the assumption that the variations in natural fertility have been progressive from plot to plot. The abnormally low yields on Plots 1 and 30 cause this method of computation to give a relatively high value to the increase on Blocks I and VI, but do not materially affect the general outcome, which is that the application of 2 tons of limestone every 6 years seems to have been more effective than that of one ton every 3 years. There seems to be some evidence, however, that a longer interval between limings may be less effective, as the corn yields for 1921, 1922, and 1923, following a 9-year vacation, have generally been smaller than those for the land receiving the limestone every 6 years.

This outcome supports the view that the first liming should be large enough to fully neutralize the land, and that it may be a better practice, as well as a more economical one, to make larger and less frequent applications. It does not cost twice as much to spread 2 tons to the acre as 1 ton, altho of course other expenses are proportionate to the quantity.

Nitrate of soda and farm manure have apparently diminished the requirement for lime, a result in harmony with those attained at Wooster, and indicating that one of the effects of liming is to increase the supply of available nitrogen, but the high cost of the nitrate has reduced the net gain.

The addition of muriate of potash has not produced any additional yield on the unlimed land, but it seems to have slightly increased the effect of the liming.

The reinforcement of manure with phosphorus, by which the nitrogen of the manure is more fully utilized, has apparently diminished the lime requirement, but not sufficiently to make liming unnecessary.

THE GERMANTOWN AND CARPENTER EXPERIMENTS

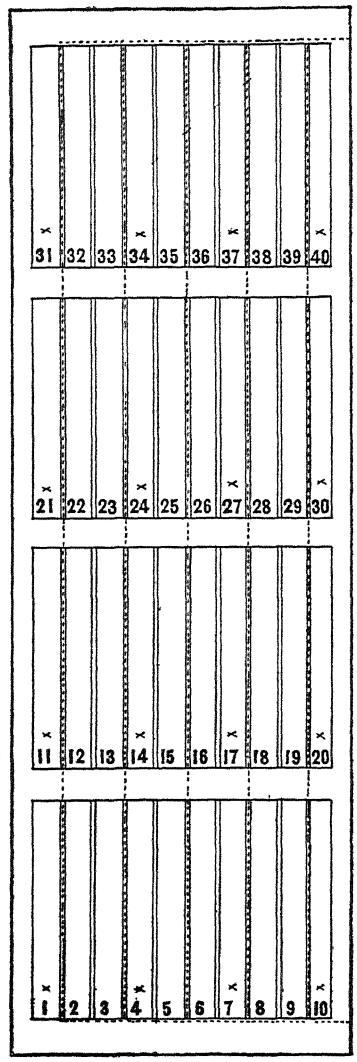
X: THE TOBACCO-WHEAT-CLOVER ROTATION

The experiment farm at Germantown is located on the divide between the Miami River and Twin Creek. The soil has been derived from the weathering of glacial drift, and this in turn has consisted largely of limestone detritus, so that the soil was originally well supplied with lime.

Tobacco has been a leading crop in this region for many years. Corn and wheat have been extensively grown, in a more or less systematic rotation with clover, the corn being chiefly fed to hogs, which had been pastured on clover, while the wheat was sold to the flouring mills or elevators, and the wheat straw to the paper mills that were located at frequent intervals along the Miami canal.

In 1903 a 3-year rotation of tobacco, wheat, and clover was begun on the experiment farm, under the plan of fertilizing shown in Table 44; three tracts of land being employed, each containing 40 one-twentieth acre plots, arranged as shown in the accompanying diagram. The results of this work for the 21 years, 1903 to 1923, are given in Tables 44, 45, and 46.

The tables are arranged in three periods, (1) covering the entire period of the test, (2) covering the first 12 years or 4 complete rotations, and (3) covering the remainder of the test to and including 1923.



DIAGRAM—Arrangement of plots in tobacco-wheat-clover rotation Sections B and O

In Table 46 and the comparisons following, the data given in Tables 44 and 45 are reduced to the common denominator of dollars and cents by valuing tobacco at 5 cents a pound and the other crops and treatments at prices stated on page

247. A much larger proportion of the cost of producing tobacco is represented in the harvesting and curing than is the case with wheat and hay, and hence the relatively low value placed on the tobacco.

Comparison of carriers of nitrogen for tobacco.—Nitrate of soda has produced a small increase when used in connection with acid phosphate, but it has apparently reduced the effectiveness of the potash salt. When the net return only is considered the nitrate has in every case reduced the profit. That this effect is due to the ability of the crops grown in this rotation to obtain their nitrogen without assistance and not to any special objection to nitrate of soda is indicated by the following comparison of nitrogen carriers, the nitrogen being given in the same quantity in each carrier and in connection with equal quantities of acid phosphate and muriate of potash:

TABLE 13.—Comparison of carriers of nitrogen for tobacco

Plot No.	Nitrogen carriers	Value of increase per acre per rotation	
		First period	Last period
	Unlimed land		
8	Nitrate of soda	$63.70	$55.33
16	Sulphate of ammonia	60.76	54.26
18	Tankage	55.04	56.25
	Limed land		
26	Nitrate of soda	65.76	63.70
28	Sulphate of ammonia	67.74	65.26
29	Tankage	57.61	60.20

The increase from sulphate of ammonia is a little less on the unlimed land and a little greater on the limed land than that from nitrate of soda, but it is not enough greater than that from the phosphate and potash without any nitrogen to cover the added cost.

Comparison of carriers of potassium for tobacco.—Three carriers of potassium have been used in this test, the muriate, sulphate, and nitrate, in association with equal quantities of acid phosphate and nitrate of soda. The outcome is shown in Table 14.

During the first period the muriate of potash outyielded the sulphate on both unlimed and limed land. During the last period the muriate has fallen behind on the unlimed land, but still leads on the limed land. The nitrate of potash was not repeated on the limed land.

Effect of lime.—Certain plots have been limed since the beginning of the test, at first with ordinary builders', or hydrated, lime, such as could be purchased in the local market, and later with ground limestone; the liming materials being applied at the rate of

TABLE 14.—Comparison of carriers of potassium for tobacco

Plot No.	Potassium carrier	Value of increase per acre per rotation	
		First period	Last period
	Unlimed land		
8	Muriate of potash	$63.70	$55.33
23	Sulphate of potash	60.50	58.78
22	Nitrate of potash	58.04	58.18
	Limed land		
26	Muriate of potash	65.76	63.70
25	Sulphate of potash	60.98	60.40

1,000 pounds per acre when preparing the land for tobacco. Tables 13 and 14 show that the liming has increased the effectiveness of the fertilizers. The total effect is shown in Table 15, in which the value of the average yield for the entire test is computed at the same prices heretofore used, this table being computed on total yields instead of on increase only.

TABLE 15.—Effect of lime on tobacco

Plot	Treatment	Average annual yield per acre				Value per acre per rotation
		Tobacco	Wheat		Clover	
			Grain	Straw		
No.		*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Dol.*
8	Unlimed	1,231	26.22	3,262	3,793	124.36
26	Limed	1,092	27.11	3,365	3,722	118.03
16	Unlimed	1,117	25.33	3,060	3,559	115.52
28	Limed	1,090	27.61	3,336	3,767	118.69
18	Unlimed	996	25.58	2,960	3,744	110.86
29	Limed	987	24.11	2,811	3,677	108.06
23	Unlimed	1,133	24.52	3,035	3,591	115.68
25	Limed	1,082	25.22	3,226	3,656	114.80
32	Unlimed	1,048	21.80	2,789	3,167	104.91
38	Limed	982	23.76	3,013	3,429	106.10

In every case the yield of tobacco has been greater on the unlimed land; in every case but one the yield of wheat has been greater on the limed land; the yield of clover has been greater on the limed land in three of the five comparisons, but the total value

of all crops has been greater on the unlimed land in three of the five comparisons, the average difference being less than 1 percent in favor of the unlimed land, not counting the cost of liming.

It must be remembered that the soil on which this test is located has been derived from glacial drift largely made up of limestone detritus.

It is possible that a single liming would improve the yields on such a soil to a sufficient extent eventually to justify its cost, but it seems evident that this soil is not yet ready to respond to the systematic liming that has become necessary in eastern Ohio.

Effect of manure.—Six plots in this test receive variously treated manure. For several years the manure was mixed horse and cow manure, the "shed" manure being taken directly from the stable to the field, while the "yard" manure was such as had accumulated in an outdoor pile thru the winter. During later years steers have been fed thru the winter for the production of manure for the test, and the manure has been so managed that equal original weights of manure have been used, either fresh from the stable or after several months exposure to the weather.

A ton of fresh manure of this character has been found, in the average of the analyses conducted at Wooster, to contain nitrogen equivalent to about 15 pounds of "ammonia", phosphorus equivalent to 6 pounds of "phosphoric acid", and potassium equivalent to 11 pounds of potash; but experience has shown that a very considerable loss of nitrogen occurs under the most careful handling before manure reaches the field; that the phosphorus in manure is more slowly available than that in acid phosphate, and that, since the potassium of manure is chiefly due to the urine it is difficult to avoid a loss of this element also; while such manure, when exposed for three months in an open barnyard, has been found to have lost more than one-third of its nitrogen, one-sixth of its phosphorus and two-thirds of its potassium. It is therefore estimated that the "shed" manure used in this test should have carried the equivalents of about 10 pounds each of ammonia and potash and 5 pounds of phosphoric acid to the ton, and the "yard" manure about 7 pounds of ammonia, 4 pounds of phosphoric acid, and 6 pounds of potash. On the basis of these estimates Table 16 has been compiled, showing, for the 21 years of the test, the estimated fertilizing constituents carried in the manure; the increase produced by the manure; the cost of the increase, if manure were rated at a farm valuation of $1 a ton, spread on the field, or if its constituents were rated at

their cost in acid phosphate, muriate of potash, and nitrate of soda; and the balance left in either case, all calculated per acre per rotation.

TABLE 16.—Effect of manure on tobacco

Plot	Fertilizing constituents			Value of increase	Cost of treatment		Balance	
	Ammonia	Phosphoric acid	Potash		Farm valuation	Chemical valuation	Farm valuation	Chemical valuation
No.	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
32	100	50	100	50.48	10.00	26.00	40.48	14.48
33	200	100	200	67.18	20.00	52.00	47.18	15.18
35	100	100	100	66.65	14.00	30.50	52.65	36.15
36	70	90	60	51.76	14.00	30.50	37.76	21.26
38*	100	50	100	56.69	15.00	31.00	41.69	25.69
39*	70	40	60	41.73	15.00	31.00	26.73	10.73

*Limed land.

The valuations in these tables are of course only relative, but they show that manure may be a very expensive fertilizer if its cost approximates the cost of its elements in chemicals, or if it be exposed to the weather until a large part of its value is lost.

Under the same conditions in other respects, the increase from the yard manure has been worth less than that from the shed manure by about $15 per rotation, or $1.50 per ton of manure. In the chemical comparison the yard manure is charged at the same original cost as the shed manure.

The most effective combination of chemicals has been that on Plot 13, in which the proportion of phosphorus is relatively high. When the manures are reinforced with acid phosphate their effectiveness is materially increased, the value of the increase being as shown below:

		21 years	First period	Second period
Plot 13	Chemicals	$71.31	$73.51	$67.40
Plot 35	Phosphated manure	66.65	62.62	72.41

Both treatments contain nearly the same quantities of phosphorus and potassium, but the manure carries twice as much nitrogen as the chemicals.

The 20 tons of manure given to Plot 33 carries about the same quantity of phosphorus as the 10 tons of phosphated manure on Plot 35, and the value of the increase is only about half a dollar more. There is apparently a waste in this heavier manuring of three-fourths of its nitrogen and half its potassium.

The conclusion would seem to be fully justified that farm manure should be carefully protected from waste, and should be employed primarily as a carrier of nitrogen and potassium, being reinforced by liberal use of acid phosphate.

During the first 12 years of this test raw phosphate rock was used in the treatment of the manure; the change was then made to 16-percent acid phosphate. It will be observed that this change was followed by increased effectiveness of the manure, whereas in general the increase during the last period has been smaller than during the first.

XI: TOBACCO GROWN CONTINUOUSLY ON THE SAME LAND

The plan of this experiment and the average results for 21 years are given in Table 50, which shows that by liberal use of fertilizers or manure, or of both in combination, it has been possible to maintain practically the same yields of tobacco under this method of culture as those obtained in the rotative cropping. The difference in outcome is found in the relative cost of maintaining the yield under the two methods.

In the continuous cropping Plot 9 has received a dressing of chemicals alone, carrying the equivalent of 60 pounds of ammonia, 45 pounds of phosphoric acid and 60 pounds of potash, costing $17.40 annually, and has given a total yield of $52.55, computing tobacco at 5 cents a pound, leaving an annual balance of $35.15, as the net value of the total crop. This has been the most profitable of the continuous treatments with chemicals alone.

In the rotative cropping Plot 8 has received chemicals equivalent to 15 pounds of ammonia, 23 pounds of phosphoric acid and 30 pounds of potash annually, the cost being for 3 years practically the same as that on Plot 9 in the continuous culture for one year, or $5.90 annually, while the rotated crops have had a total value for the 3-year period of $124.36, or $41.45 annually, leaving an annual balance of $35.55.

On the manured land, Plot 16 in the continuous cropping has received each year 13 tons of manure and 200 pounds of acid phosphate and has produced a gross value of $61. The total cost of treatment is $15, leaving a balance of $46.

In the rotative cropping Plot 35 has had 10 tons of manure reinforced with 400 pounds of acid phosphate for each rotation, equivalent to an annual cost of $4.67, and has returned annually $39.95, or $35.28 in excess of the cost of the fertilizer.

This outcome, compared with that of the continuous cropping of the cereals at Wooster, indicates that, with an abundant supply of cheap fertilizer on the one hand and a crop of high acre-value on the other, continuously grown crops may successfully compete with those grown in rotation; but were manure computed at the price

which would be required to replace its constituents in chemicals the cost of fertilizing Plot 16 would be more than $30 annually, and that of Plot 35 about $8, so that the balance would be practically the same.

On the unfertilized land the average annual values have been $16.65 for the continuously grown tobacco and $18.68 for the rotated crops, computing tobacco at 5 cents a pound, but with tobacco at 10 cents the values would be $33.30 and $27.52, respectively.

XII: THE CORN-WHEAT-CLOVER ROTATION AT GERMANTOWN

The soil on which this test is located is a typical Miami "yellow-and-black" soil—the yellow largely predominating in this case—derived from glacial drift consisting chiefly of limestone detritus, but weathered to such a depth that drainage has become necessary.

The plan of the experiment is given on page 347. Previous reports have been made in Bulletins 182, 184, and 336. Table 48 gives the fertilizing constituents applied, reckoned in the trade terms and annual equivalents of ammonia, phosphoric acid, and potash, tho in fact the fertilizers have been applied only to the corn and wheat, as shown on page 347.

In the earlier years of the test 14 percent acid phosphate was used and 16 percent during recent years. If the constituents of the manure were computed at the same rates as those used for chemical fertilizers its cost would amount to $1.90 a ton for yard manure or $2.70 a ton for shed manure, on the composition here assumed. For prices see page 247.

The use of tankage as a feeding stuff has increased to such an extent during recent years as to materially increase its cost and thus prohibit its use as a fertilizer. This part of the experiment is therefore being revised.

Table 48 shows that acid phosphate, used alone at the rate of 120 pounds per acre each on corn and wheat, equivalent to an annual cost of 85 cents per acre, has increased the yield by an annual value of $5.90, or about seven times the cost of the fertilizer.

The addition of 20 pounds of potash to each dressing of acid phosphate, raising the annual cost to $1.20, has raised the annual increase to $8.55. The further addition of 80 pounds of nitrate of soda to each dressing has raised the annual increase to $10; but the cost of the nitrate has reduced the net balance to $6.95, as against $7.35 for acid phosphate and potash, and $5.05 for acid phosphate

alone. When the acid phosphate is doubled, Plot 12, the nitrogen and potash remaining unchanged, the net balance rises to $9.19, or nearly twice that from acid phosphate alone. This has been the most profitable treatment in the series.

When the nitrogen and potash are increased, Plot 14, the acid phosphate remaining as on Plot 11, there is a further increase of about $2 in the total yield, but that is not sufficient to cover the added cost of the fertilizer. The concentration of this fertilizer on the corn with the addition of lime to the wheat, Plot 15, has reduced the yield.

Effect of manure and lime.—The substitution of manure and lime, Plot 17, for this combination of chemicals and lime, has reduced the total yield by about $4 annually. As between manuring the corn and liming the wheat, or liming the corn and manuring the wheat, the comparison of Plot 17 with Plot 21 shows too small a difference to be significant; and the same may be said of the comparison of Plot 18, in which both manure and lime are given to the corn only, with Plot 20, in which both are given to the wheat only, altho in both cases the difference is slightly in favor of feeding the corn at the first table.

Even at the low cost assumed for the manure the balance left after paying this cost is less than that from the better proportioned chemical fertilizer. When the manure is reinforced with phosphate the outcome is improved, but were the constituents of manure charged at their cost in chemicals the cost would materially reduce the final balance.

Plot 5 illustrates the inefficiency of a fertilizer for this soil carrying nitrogen and potash only, and the table shows that the effectiveness of the manure has practically been measured by the small amount of phosphorus carried.

Until 1915 raw phosphate was used in the reinforcement of the manure in this test, and since that date acid phosphate has been used, the quantity of phosphate per ton of manure remaining unchanged. The annual value of the increase per acre during the two periods is shown in Table 17.

The increase during the second period on Plot 27 from shed manure reinforced with acid phosphate is nearly as great as that on Plot 12, and suggests a larger use of acid phosphate in connection with manure. As compared with the tankage fertilizers, the shed manure reinforced with acid phosphate appears to be fully equal in effect to the fertilizer.

TABLE 17.—Annual value per acre of increase from manure

Plot	Period I, 1904-1915		Period II, 1916-1923	
23	Yard manure, untreated	$4.52	Yard manure, untreated	$4.67
26	Yard manure, raw phosphate	6.37	Yard manure, acid phosphate	7.69
	Gain for treatment	1.85	Gain for treatment	3.02
24	Shed manure, untreated	7.92	Shed manure, untreated	8.43
27	Shed manure, raw phosphate	7.78	Shed manure, acid phosphate	12.44
	Gain for treatment	.14	Gain for treatment	4.01

As between the yard and shed manures the annual effect of the untreated manure was $3.40 greater per acre during the first period and $3.76 greater during the second for the shed manure than for the yard manure, and was $1.41 greater for the addition of raw phosphate and $4.75 greater for that of acid phosphate.

These results are in line with those in the tobacco rotation and with similar work at Wooster and Strongsville, and point unmistakably towards the more careful saving of farm manure and its use primarily as a carrier of nitrogen and potassium, to be reinforced with phosphorus, thus taking the place of the more costly elements of the fertilizer.

The effect of liming this soil is shown in Table 18:

TABLE 18.—Annual increase per acre, its total value for the 3 crops and the gain for liming

Plot	Corn		Wheat		Clover hay	Total gain for liming
	Grain	Stover	Grain	Straw		
	Bu.	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Dol.*
17—Limed	18.59	992	5.51	687	655	.....
24—Unlimed	17.80	709	4.97	586	388	.....
Gain for liming	.79	283	.54	101	267	4.05
29—Limed	18.64	1,211	8.18	1,003	772	.....
27—Unlimed	18.10	917	7.00	737	437	.....
Gain for liming	.54	294	1.18	266	335	5.47
41—Lime only	4.04	247	.60	212	636	9.34

(Plots 14 and 15 cannot be compared, because the concentration of the fertilizer on Plot 15 has reduced its effect.)

The principal gain for liming has been in the stover, straw, and hay. The increase has been greater where limestone has been used

alone than when used in connection with manure, presumably because manure contains some lime.

While the present demand of this soil for lime is less urgent than that of the soils derived from sandstones, it is probable that, under the system of agriculture now prevailing over most of Ohio, in which the proportion of livestock to land in cultivation is much smaller than it was half a century ago, reducing the relative quantity of manure, there will be an increasing lime requirement.

It was not until near the close of the last century that the soils of eastern Ohio began to manifest a hunger for lime. Some of the older soils in southwestern Ohio, as measured by geologic age, such as those in Clermont, Brown, and Adams Counties, are now calling for lime, and there is little doubt that many of the older fields in the Miami Valley will respond profitably to an occasional dose of lime, but the time does not seem yet to have arrived for the systematic liming that is required by the sandstone soils.

PRACTICAL APPLICATION

Several of the treatments employed in this experiment have increased the yield of corn to a 20-year average of 60 bushels per acre and several have raised the yield of wheat to averages of 24 to 26 bushels. For Montgomery County as a whole—including the broad, rich bottoms and terraces of the Miami and many farms on which considerable use was made of manure and fertilizers—the average acre yields for the 20 years, 1900-1919, were 39 bushels of corn and 17 bushels of wheat. There would seem to be no room for doubt that by more carefully saving the manure and a more liberal use of acid phosphate as a reinforcement of or supplement to the manure, in connection with drainage where necessary and the systematic growing of clover, using lime or limestone when required by the clover, the net returns from Montgomery County's farms might be materially increased.

XIII: THE CORN-WHEAT-CLOVER ROTATION AT CARPENTER

The Carpenter farm is located in the northwestern quarter of Meigs County, about 15 miles south of Athens. It lies south of the glaciated area, and its soil is a typical Dekalb silt loam, formed by the decomposition of the shales and sandstones of the barren coal measures. This region of the state is so hilly that it is difficult to find land sufficiently level for plot experiments, and the work on this farm is limited to three sections of 20 plots each devoted to a 3-year rotation of corn, wheat, and clover.

This experiment was begun at the same time as the one at Germantown, and the plan of fertilizing is a duplicate of the first 20 plots in the cereal rotation there. The yields and increase from treatment are given for the 20 years, 1904-1923, in Table 51 and the financial results are shown in Table 52, the results of the similar treatments at Germantown being added to show the differences between the two soils.

The principal differences in the outcome in the two tests are a smaller effect of potassium and a larger effect of lime at Carpenter than at Germantown. The difference in effect of lime is easily explained by the geological history of the two soils, the Germantown soil having been derived from gravel that was chiefly of limestone origin, while the Carpenter soil is the residium from the weathering of non-calcareous rocks.

In both tests the combination used on Plot 12, which is relatively high in phosphorus as compared with nitrogen and potassium, is giving the largest net gain on unlimed land. In both cases the constituents of manure must be rated at much less than their cost in chemicals if manure is to be used with profit, but while liming has increased the net gain at Carpenter it has reduced it at Germantown. At Carpenter, as at Germantown, the concentration of all the fertilizer on the corn crop, on Plot 15, instead of dividing it between the corn and wheat, as on Plot 14, has reduced the profit.

The unfertilized yields in the two tests have been as shown below:

	Average unfertilized yield	
	Carpenter	Germantown
Corn, bu.	24.73	39.28
Wheat, bu.	9.08	9.90
Clover, lb.	1,097	1,990

In both experiments the clover has failed during recent years. In 1919, 1920, and 1921 at Carpenter and in 1919, 1920, and 1922 at Germantown it was cut and left on the land. In 1923 an average crop was harvested at Germantown, but at Carpenter the growth was about 90 percent weeds on the unlimed land and about 40 percent on the limed land. The yield of this year has been included in the average, however, as the chief object of the test is to study the effect of fertilizers on the total production of the land.

At Carpenter it seems that the time has arrived, as it did at Wooster 20 years ago, when all the land must be limed before red clover can be grown. Other factors than lack of lime, however, seem to be at work in the Miami Valley.

XIV: THE CORN-OATS-WHEAT-CLOVER ROTATION AT FINDLAY

This experiment was begun in 1909 in a field of 20 acres that had formerly been used as a fairground, but which was leased to the Experiment Station for experimental purposes. The soil of the part of the field devoted to fertility experiments is the yellow Miami clay loam. It was not practicable to underdrain the land until after the work had been in progress for several years, and this fact, together with the irregularities due to the former use of the land, has caused considerable variation in the yield independently of the treatment given; but the frequent repetition of check plots has made it possible to reach some conclusions that may be safely accepted.

The plan of fertilizing and average yields thus far attained are given in Table 53, the yields and increases in Table 54, and in Table 19 is shown the financial outcome, using the valuations heretofore employed—all calculations being per acre per annum.

TABLE 19.—The corn-oats-wheat-clover rotation at Findlay. Fertilizing constituents, cost of treatment, value of increase and balance. All computed per acre per annum

Plot	Fertilizing constituents				Cost of treatment	Value of increase	Balance
	Ammonia	Phosphoric acid	Potash	Lime-stone			
No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*
2	....	13	.....	....	.90	4 62	3.72
3	.....	13	7.5	.... . .	1.30	6.05	4.75
5	7.5	.....	7.5	.. .. ..	1.80	4.55	2.75
6	7.5	13	.....	.....	2.30	6.29	3.99
8	7.5	13	7.5	.....	2.70	5.28	2.58
9	7.5	13	7.5	500	3.95	7.15	3.20
11	25*	13*	20*	.....	2.50	10.60	8.10
12	12*	18†	10*	500	3.10	10.34	7.24
14	25*	25‡	20*	.....	3.10	13.33	10.23

*All in manure. †38% in manure. ‡55% in manure.

Acid phosphate has increased the yield by five times its cost, and muriate of potash has added more than twice its cost to the increase produced by acid phosphate. Nitrate of soda, however, has failed to pay its cost. Limestone appears to have added a little more than its cost to the yield produced by chemical fertilizers; but it has not been profitable to replace manure with limestone, if manure can be laid on the land at a cost not exceeding one dollar a ton.

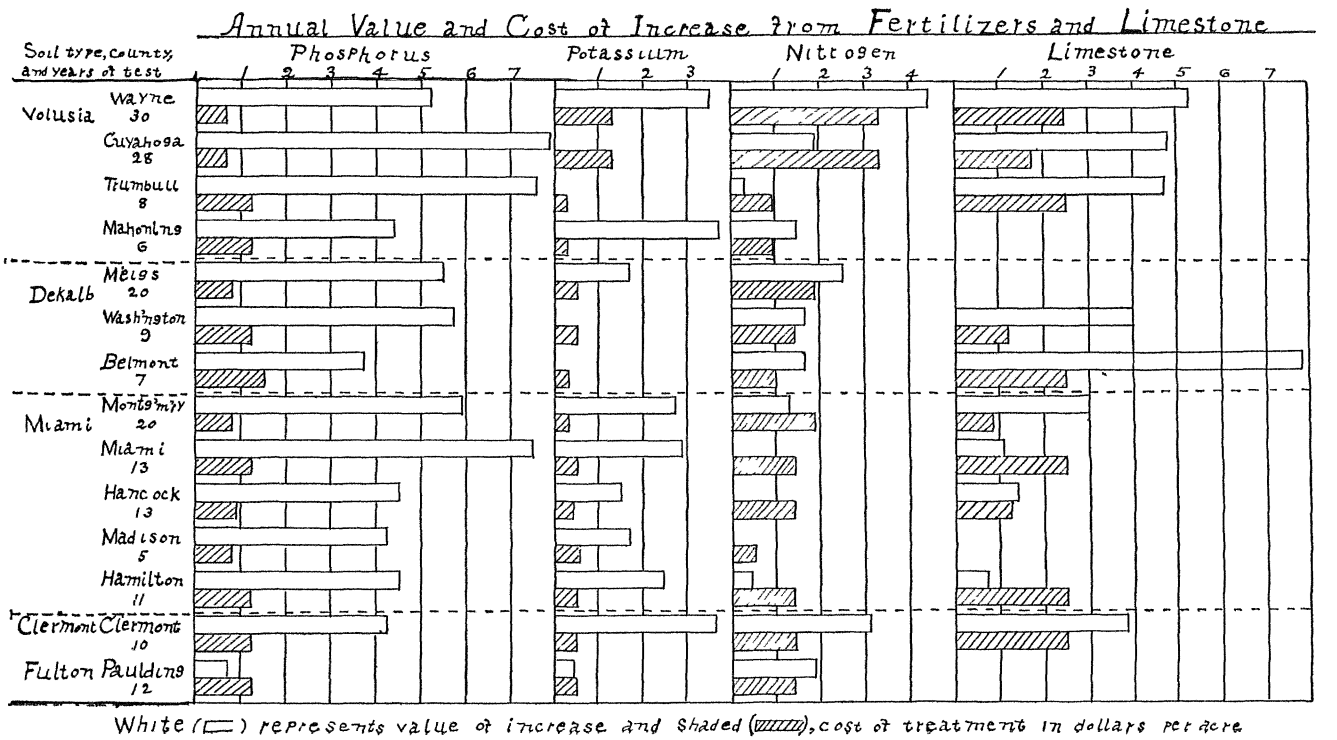
The statistics of livestock and crop production, however, show that the livestock kept in Hancock County would not furnish more than about 3 tons of manure for each acre planted to corn, if only

that produced during the winter were saved and used, while the purchase of chemical fertilizers in 1918 would have supplied only about 150 pounds for each acre sown to oats and wheat. In the absence of manure there is no ground for doubt that the use of fertilizers carrying phosphorus and potassium might be increased with profit. This experiment has been discontinued.

SUMMARY

In addition to the experiments described in the preceding pages, similar tests are in progress on 9 county experiment farms, widely scattered over the State, the plans and outcome of which to 1921 have been published in Bulletin 361. In Table 50 is given a brief summary, showing for all the tests with cereal crops the value of the increase produced by acid phosphate, the value of the increase from acid phosphate and muriate of potash in excess of that produced from acid phosphate alone, the value of the increase from acid phosphate, muriate of potash and nitrate of soda in excess of that produced by acid phosphate and muriate of potash, and the additional value found when limestone is added to the complete fertilizer, or to manure. The same results are also graphically shown in the accompanying diagram, in which the increase from fertilizers is shown by white lines and the cost of treatment by shaded lines, all being computed for one acre one year, and on valuations equivalent to those employed thruout this bulletin. (See page 247).

The diagram brings out strikingly the importance of phosphorus. It shows an irregular action of potassic fertilizers on the soils overlying sandstones (Volusia and Dekalb) but an increase amounting to several times the additional cost on every soil overlying limestones, excepting that in Paulding County, which differs radically in origin and behavior from all the other soils under test. It shows that no Miami soil has been willing to pay for commercial nitrogen, and only one Miami soil—that at Germantown, Montgomery County—has justified the use of limestone, while every Volusia and Dekalb soil is shouting for lime. The experiment in Mahoning County gives no opportunity to study the effect of lime, as all the land is limed; but the similarity of the Mahoning and Wooster soils and of the outcome of treatment in other respects leaves no room to doubt that lime is necessary. At Carpenter, Meigs County, the test is so arranged that the effect of liming can only be measured in the clover crop. That crop has practically refused to grow on unlimed land.


Annual Value and Cost of Increase from Fertilizers and Limestone
Soil type, county and years of test
Phosphorus
Potassium
Nitrogen
Limestone
1 2 3 4 5 6 7
1 2 3
1 2 3 4
1 2 3 4 5 6 7
Volusia
Wayne 30
Cuyahoga 25
Trumbull 8
Mahoning 6
Dekalb
Meigs 20
Washington 9
Belmont 7
Miami
Montgomery 20
Miami 13
Hancock 13
Madison 5
Hamilton 11
Clermont
Clermont 10
Fulton
Paulding 12
White (□) represents value of increase and shaded (▨), cost of treatment in dollars per acre

The Wooster soil, at the top of the diagram, and the Clermont soil, near the bottom—two soils located in opposite quarters of the State, the one over sandstones and the other over limestones, show a marked similarity in outcome. Both farms had at one time supported a prosperous agriculture, as indicated by substantial brick and stone houses and large barns, but both had been reduced by improvident husbandry to such a condition that the chief function of their soils now is to serve as standing places for the crops, in which their roots may range for water and for the plant food supplied by artificial feeding. What has been accomplished on these soils is shown by the following 10-year averages of the yields on unfertilized land and on land alongside receiving chemical fertilizers only.

	10-year average annual yield per acre	
	Corn Bu.	Wheat Bu.
Wooster, unfertilized	18.83	9.50
fertilized	54.80	32.40
Clermont, unfertilized	20.35	7.55
fertilized	44.15	23.84

These are not the highest yields that have been attained, the yield of corn having been brought up to a 20-year average of more than 70 bushels per acre in field culture at Wooster, and that of wheat following potatoes to a 28-year average of 38 bushels per acre at Wooster and a 9-year average of 30 bushels per acre on the Clermont farm.

CONCLUSIONS

Continuous vs. rotative cropping.—Corn, oats, and wheat have been grown every year for 30 years on the same land and also in rotation with clover and timothy, with the outcome that, while it has been possible to maintain fair average yields under continuous cropping by the liberal use of manure or of chemical fertilizers approaching manure in composition, the crops grown in rotation have given larger yields with a much lower expenditure for manure or fertilizers (page 249).

Liming the land.—Experiments in the use of lime and limestone, conducted in 10 counties of the State, indicate that for the soils overlying sandstones or non-calcareous shales and for the soils over limestone of the more ancient glaciation in southwestern Ohio the systematic addition of lime-bearing materials has become indispensable to the attainment of the most profitable crop yields; but that over the more recently glaciated limestones the response to liming is likely to be relatively small (pages 251, 256, 257, 260, 274, 277, 280, 287).

Phosphorus.—With but one exception—the bed of ancient Lake Maumee in Paulding County, the newest land in Ohio in both geologic and agricultural history—every soil and every crop under test has responded profitably to phosphorus, the most effective carrier of which is acid phosphate, with basic slag and steamed bonemeal following closely (page 257). Raw phosphate rock has caused material increase in yield, but the effect of acid phosphate is so much greater as to render the use of raw phosphate relatively unprofitable (page 259 and 265).

Potassium.—On the Miami soils muriate of potash, when added to acid phosphate in relatively small quantity, has given a profitable increase of crop. On the soils overlying sandstones the effect of potassium has been irregular, seeming to be partly dependent upon the addition of lime as well as of phosphorus. It has practically never been profitable to use potassium in the absence of phosphorus (page 292).

Nitrogen.—Nitrogen in nitrate of soda, when used on cereal crops grown in rotation with clover, has failed to repay its cost in 6 of the 14 counties in which these experiments are located, and the margin of profit has been relatively small in all. The results strongly indicate that for Ohio conditions the nitrogen supply for such crops should be secured thru their systematic rotation with leguminous crops and the careful saving of manure.

Of the carriers of nitrogen employed—nitrate of soda, sulphate of ammonia, linseed oilmeal, dried blood, and tankage—nitrate of soda has been the most effective. Sulphate of ammonia has been second on land supplied with lime, but on acid soil it aggravates the unfavorable conditions (page 255).

Farm manure.—Farm manure has been used alongside of chemicals in every test, with the outcome that a lower estimate than has been customary must be put upon the composition of such manure if the effect of its nitrogen, phosphorus, and potassium is to equal that of the same elements in such carriers as nitrate of soda, acid phosphate, and muriate of potash. As ordinarily handled, a large part of the value of manure is lost before it reaches the field. Another large loss is incurred thru overlooking the fact that the system of agriculture pursued in Ohio tends to a relative deficiency of the soil in phosphorus, and therefore that manure should be systematically reinforced or supplemented with this element in order to produce its maximum effect.

Clover in wheat stubble on limed (left) and unlimed (right) ends of plots in 5-year rotation at Wooster

Tobacco, Plot 10 (left) unfertilized and Plot 9 (right) fertilized, in tobacco-wheat-clover rotation at Germantown

TABLE 20, A.—Corn grown in CONTINUOUS CULTURE at Wooster
Average annual yield and increase per acre by 5-year periods

Plot No.	Treatment Pounds per acre	1894-1923		1894-1898		Plot No.
		Grain Bu.	Stover Lb.	Grain Bu.	Stover Lb.	
	Yield					
1	None	19.29	1,328	29.19	1,449	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	38.89	2,112	44.61	2,076	2
3	Acid phosphate, 60; muriate potash, 30; nitrate soda, 160	31.04	1,745	38.86	1,770	3
4	None	12.65	1,088	28.86	1,436	4
5	Yard manure, 2½ tons	23.98	1,601	36.44	1,670	5
6	Yard manure, 5 tons	33.85	1,960	43.13	1,938	6
7	None	11.97	1,064	25.53	1,304	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	43.89	2,186	44.43	2,008	8
9	Acid phosphate, 120; muriate potash, 60; nitrate soda, 320	40.86	2,029	42.76	1,870	9
10	None	9.48	921	21.44	1,170	10
*		13.33	1,109	26.26	1,339	
	Increase					
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	21.81	863	15.53	630	2
3	Acid phosphate, 60; muriate potash, 30; nitrate soda, 160	16.17	577	9.88	330	3
5	Yard manure, 2½ tons	11.56	521	8.68	278	5
6	Yard manure, 5 tons	21.65	888	16.49	590	6
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	32.75	1,169	20.26	749	8
9	Acid phosphate, 120; muriate potash, 60; nitrate soda, 320	30.55	1,061	19.96	655	9

Plot No.	1899-1903		1904-1908		1909-1913		1914-1918		1919-1923		Plot No.
	Grain Bu.	Stover Lb.	Grain Bu.	Stover Lb.	Grain Bu.	Stover Lb.	Grain Bu.	Stover Lb.	Grain Bu.	Stover Lb.	
	Yield										
1	21.85	1,234	17.09	1,546	15.82	1,490	16.36	1,166	15.43	1,084	1
2	47.21	2,202	38.50	2,520	36.41	2,496	33.71	1,700	32.90	1,674	2
3	39.09	1,820	28.00	2,138	26.83	2,016	25.53	1,356	27.93	1,370	3
4	16.81	1,106	9.09	1,162	6.34	1,220	7.31	816	7.51	790	4
5	29.21	1,588	23.77	1,958	18.92	1,830	18.67	1,364	16.90	1,196	5
6	40.11	1,924	34.62	2,404	30.22	2,296	30.19	1,716	24.83	1,480	6
7	15.74	1,060	8.86	1,232	6.95	1,204	7.77	834	6.92	750	7
8	52.55	2,376	44.55	2,568	45.82	2,698	37.29	1,842	38.71	1,622	8
9	50.13	2,232	41.73	2,458	41.97	2,512	34.14	1,650	34.44	1,454	9
10	12.65	934	6.64	996	4.63	970	5.16	736	6.33	718	10
*	16.76	1,083	10.34	1,231	8.44	1,221	9.15	888	9.05	835	
	Increase										
2	27.03	1,013	24.08	1,394	23.75	1,096	20.36	651	20.11	688	2
3	20.59	671	16.25	848	17.33	706	15.20	423	17.78	482	3
5	12.75	497	14.75	773	12.38	615	11.20	542	9.59	419	5
6	24.01	851	25.65	1,195	23.48	1,087	22.57	888	17.71	717	6
8	37.85	1,358	36.41	1,415	39.64	1,572	30.39	1,041	31.99	883	8
9	36.45	1,256	34.34	1,383	36.56	1,464	28.10	881	27.91	725	9

*Averaged unfertilized yields.

TABLE 20, B.—Oats grown in CONTINUOUS CULTURE at Wooster
Average annual yield and increase per acre by 5-year periods

Plot No.	Treatment Pounds per acre	1894-1923		1894-1898		Plot No.
		Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	
	Yield					
1	None	19.13	786	26.87	892	1
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	39.37	1,987	42.22	1,697	2
3	Acid phosphate, 55; muriate potash, 50; nitrate soda, 160	35.84	1,662	38.75	1,470	3
4	None	20.15	815	28.67	1,059	4
5	Yard manure, 2½ tons	28.54	1,242	30.83	1,021	5
6	Yard manure, 5 tons	35.77	1,828	34.81	1,265	6
7	None	20.88	912	27.94	1,110	7
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	46.00	2,580	48.75	2,086	8
9	Acid phosphate, 110; muriate potash, 100; nitrate soda, 320	44.14	2,465	46.94	1,982	9
10	None	21.87	929	29.28	1,125	10
*		20.53	864	28.19	1,046	
	Increase					
2	Acid phosphate, 160; muriate potash, 100; nitrate soda, 160	19.90	1,191	14.75	749	2
3	Acid phosphate, 55; muriate potash, 50; nitrate soda, 160	16.03	857	10.67	467	3
5	Yard manure, 2½ tons	8.15	395	2.40	—55	5
6	Yard manure, 5 tons	15.14	948	6.63	173	6
8	Acid phosphate, 160; muriate potash, 100; nitrate soda, 320	24.79	1,662	20.37	971	8
9	Acid phosphate, 110; muriate potash, 100; nitrate soda, 320	22.60	1,482	18.10	862	9

Plot No.	1899-1903		1904-1908		1909-1913		1914-1918		1919-1923		Plot No.
	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	
	Yield										
1	16.75	578	20.40	855	15.54	815	21.29	893	13.92	608	1
2	40.11	1,701	45.46	2,136	34.47	2,204	43.01	2,224	30.95	1,821	2
3	36.47	1,463	40.79	1,890	30.89	1,710	39.55	1,805	28.61	1,444	3
4	19.66	697	21.80	855	18.15	915	19.34	755	13.26	535	4
5	28.51	1,030	35.03	1,565	26.09	1,447	28.79	1,186	22.00	990	5
6	36.76	1,516	44.10	2,232	33.84	2,212	37.44	1,990	27.70	1,576	6
7	21.82	846	22.55	974	18.81	1,064	19.48	805	14.71	579	7
8	48.87	2,342	47.89	2,675	40.70	2,816	51.48	2,897	38.31	2,652	8
9	47.36	2,131	45.61	2,548	38.89	2,669	49.31	2,647	36.77	2,281	9
10	23.43	856	22.98	936	19.45	1,019	21.59	850	14.47	694	10
*	20.41	744	21.93	905	18.14	953	20.43	826	14.08	604	
	Increase										
2	22.39	1,083	24.59	1,279	18.06	1,356	22.36	1,377	17.25	1,238	2
3	17.78	806	19.46	1,037	13.60	628	19.56	1,004	15.13	885	3
5	8.13	283	12.98	670	7.72	482	9.41	415	8.26	440	5
6	15.67	720	21.83	1,297	15.25	1,198	18.00	1,202	13.49	1,012	6
8	26.51	1,493	25.17	1,712	21.68	1,767	31.30	2,076	23.70	2,034	8
9	24.46	1,478	22.80	1,601	19.65	1,625	28.42	1,812	22.23	1,624	9

*Averaged unfertilized yields.

TABLE 20, C.—Wheat grown in CONTINUOUS CULTURE at Wooster
Average annual yield and increase per acre by 5-year periods

Plot No.	Treatment Pounds per acre	1894-1923		1894-1908		Plot No.
		Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	
	Yield					
1	None	5.22	707	10.56	1,334	1
2	Acid phos., 160; mur. potash, 100; nit. soda, 120; dried blood, 50	16.38	2,299	19.78	2,205	2
3	Acid phos., 45; mur. potash, 30; nit. soda, 120; dried blood, 50	11.36	1,576	16.33	1,720	3
4	None	5.72	817	10.26	1,044	4
5	Yard manure, 2½ tons	13.43	1,748	13.28	1,475	5
6	Yard manure, 5 tons	19.41	2,517	15.77	1,743	6
7	None	5.41	759	9.95	1,045	7
8	Acid phos., 160; mur. potash, 100; nit. soda, 280; dried blood, 50	20.51	2,819	20.69	2,510	8
9	Acid phos., 90; mur. potash, 60; nit. soda, 280; dried blood, 50	17.09	2,324	19.01	2,159	9
10	None	3.52	448	9.55	1,051	10
*		4.97	683	10.08	1,110	
	Increase					
2	Acid phos., 160; mur. potash, 100; nit. soda, 120; dried blood, 50	10.99	1,555	9.32	967	2
3	Acid phos., 45, mur. potash, 30; nit. soda, 120; dried blood, 50	5.81	796	5.97	579	3
5	Yard manure, 2½ tons	7.81	950	3.13	430	5
6	Yard manure, 5 tons	13.90	1,739	5.72	698	6
8	Acid phos., 160; mur. potash, 100; nit. soda, 280; dried blood, 50	15.73	2,164	10.87	1,463	8
9	Acid phos., 90; mur. potash, 60; nit. soda, 280; dried blood, 50	12.94	1,772	9.33	1,110	9

Plot No.	1899-1903		1904-1908		1909-1913		1914-1918		1919-1923		Plot No.
	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	
	Yield										
1	7.86	926	5.95	1,038	5.10	896	8.34	1,089	7.17	998	1
2	21.90	2,420	17.41	2,701	17.28	2,559	22.32	3,012	19.18	2,533	2
3	16.90	1,644	13.31	2,158	14.80	2,039	17.25	2,157	14.99	1,882	3
4	8.76	940	6.68	973	6.16	845	9.08	1,029	7.78	941	4
5	14.26	1,498	12.23	1,973	14.09	1,913	17.75	2,060	14.17	1,778	5
6	18.46	2,014	17.48	2,670	18.75	2,542	23.48	2,917	18.89	2,401	6
7	9.38	965	6.11	1,025	5.96	871	9.44	989	7.71	942	7
8	25.26	2,724	20.88	3,208	22.04	3,191	25.09	3,488	22.41	2,990	8
9	22.45	2,181	19.12	2,846	20.06	2,641	25.99	2,940	20.29	2,515	9
10	7.62	805	6.00	858	4.38	648	6.94	775	6.33	764	10
*	8.41	909	6.19	943	5.40	765	8.45	975	7.25	937	
	Increase										
2	13.73	1,489	11.21	1,684	11.82	1,680	13.74	1,943	11.80	1,553	2
3	8.42	709	6.87	1,163	8.99	1,178	8.41	1,108	7.41	922	3
5	5.28	550	5.74	982	7.99	1,060	8.55	1,045	6.42	836	5
6	9.28	1,057	11.18	1,663	12.72	1,680	14.15	1,915	11.16	1,458	6
8	16.47	1,810	14.80	2,239	16.60	2,394	16.48	2,570	15.16	2,107	8
9	14.25	1,323	13.10	1,933	15.15	1,919	16.22	2,094	13.50	1,692	9

*Averaged unfertilized yields.

PLAN OF FERTILIZING IN 5-YEAR ROTATION AT WOOSTER

Plots one-tenth acre—Fertilizing materials in pounds per acre

Plot No.	On corn			On oats			On wheat			
	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Dried blood	Nitrate of soda
1	....	....	....	....	....	....	....	....	....	....
2	80	....	....	80	....	....	160	....	....	....
3	...	80	....	....	80	....	....	100	....	....
4	....	....	....	....	....	....	....	....	....	....
5	....	....	160	....	....	160	....	....	50	120
6	80	....	160	80	....	160	160	....	50	120
7	....	....	....	....	....	....	....	....	....	....
8	80	80	....	80	80	....	160	100	....	....
9	....	80	160	....	80	160	....	100	50	120
10	....	....	....	....	....	....	....	....	....	....
11	80	80	160	80	80	160	160	100	50	120
12	80	80	240	80	80	240	160	100	50	200
13	....	....	....	....	....	....	....	....	....	....
14	80	80	160	....	....	....	160	100	50	120
15	....	....	....	....	....	....	160	100	50	120
16	...	....	....	....	....	....	....	....	....	....
17	160	80	80	160	80	80	160	100	25	60
18	Barnyard manure, 8 tons each on corn and wheat									
19	....	....	....	....	....	....	....	....	....	....
20	Barnyard manure, 4 tons each on corn and wheat									
21	Same elements as 17, but nitrogen in oilmeal									
22	....	....	....	....	...	....	....	....	....	....
23	Same elements as 17, but nitrogen in dried blood									
24	Same elements as 17, but nitrogen in sulphate of ammonia									
25	....	....	....	....	....	....	....	....	....	....
26	Same elements as 11, but phosphorus in bonemeal									
27	Same elements as 17, but nitrogen in nitrate of lime									
28	....	....	....	....	....	...	....	....	....	....
29	Same elements as 11, but phosphorus in basic slag									
30	Same elements as 17, but nitrogen in tankage									

Note: During first 5 years quantities of elements on Plots 17, 21, 23, and 24 same as 11; nitrogen and potassium on 30 smaller. Previous to 1910 Plot 27 same as 11, with nitrogen in nitrate of soda, phosphorus in dissolved boneblack. Treatment on Plots 12, 21, and 23 changed in spring of 1921 to 320 pounds acid phosphate on each grain crop; nitrate of soda for oilmeal and dried blood on 21 and 23; muriate of potash reduced one-half on 23; treatment on 30 discontinued.

TABLE 21.—Yield and increase of CORN grown in 5-year rotation at Wooster—Bushels per acre
Averaged by 5-year periods and for total period of 30 years

Plot No.	1894-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	31.88	.....	32.92	.....	26.87	.....	19.12	.....	19.40	.....	1
					34.36	.....	26.43	.....	26.27	.....	
2	36.02	3.96	41.90	9.74	38.55	11.38	23.96	5.99	27.90	8.28	2
					42.00	7.55	34.02	9.17	29.90	3.96	
3	34.93	2.69	36.14	4.74	35.47	8.01	19.49	2.67	26.98	7.14	3
					39.62	5.10	26.83	3.54	37.63	12.04	
4	32.43	.....	30.64	.....	27.76	.....	15.66	.....	20.07	.....	4
					34.60	.....	21.72	.....	25.26	.....	
5	35.38	2.33	36.24	5.75	34.56	6.27	20.60	4.65	28.47	7.46	5
					40.33	5.46	26.95	4.89	35.12	8.75	
6	43.32	9.65	47.61	17.26	43.94	15.11	32.70	16.46	38.36	16.40	6
					49.94	14.80	37.51	15.11	40.50	13.03	
7	34.29	.....	30.20	.....	29.36	.....	16.53	.....	22.90	.....	7
					35.41	.....	22.74	.....	28.58	.....	
8	40.11	7.21	44.49	14.17	47.75	19.32	34.13	17.20	40.39	18.43	8
					52.97	18.57	41.08	17.62	48.87	20.17	
9	33.00	1.48	36.62	6.19	36.41	8.92	26.88	9.55	29.91	8.89	9
					44.34	10.94	34.01	9.84	41.96	13.13	
10	30.13	.....	30.55	.....	26.55	.....	17.73	.....	20.09	.....	10
					32.40	.....	24.88	.....	28.94	.....	
11	41.28	10.72	49.90	19.45	51.29	24.63	35.98	19.05	41.73	21.39	11
					56.68	23.34	46.75	22.74	50.94	22.05	
12	41.07	10.09	52.18	21.82	51.77	25.01	36.98	20.89	42.33	21.74	12
					54.39	20.11	45.36	22.23	51.41	22.58	
13	31.41	.....	30.26	.....	26.87	.....	15.30	.....	20.84	.....	13
					35.20	.....	22.24	.....	28.79	.....	
13	40.96	10.27‡	47.81	18.33	46.20	19.74	31.94	16.74	41.63	21.02	14
					51.40	17.30	40.01	18.46	46.10	18.41	
15	32.26	5.92	35.52	6.83	35.30	9.24	20.63	5.54	29.33	8.95	15
					42.85	9.87	28.35	4.48	35.41	8.83	
16	29.23	.....	27.91	.....	25.68	.....	14.98	.....	20.13	.....	16
					31.86	.....	20.17	.....	25.49	.....	
17	35.78	6.59§	49.54	20.48	50.66	24.66	41.46	26.41	41.64	20.71	17
					57.15	23.11	46.75	25.38	50.83	24.97	
18	40.73	10.04§	49.52	19.32	56.77	30.46	53.39	38.27	51.76	30.03	18
					63.85	27.62	58.24	35.66	58.71	32.48	
19	33.12	.....	31.35	.....	26.63	.....	15.18	.....	22.53	.....	19
					38.41	.....	23.77	.....	26.60	.....	
20	38.91	7.10	43.08	12.83	45.83	19.95	35.02	20.15	39.50	17.50	20
					54.73	17.42	43.45	19.18	45.57	17.79	
21	37.66	7.16	48.79	19.63	48.29	23.17	36.76	22.18	43.21	21.75	21
					59.60	23.40	50.00	25.25	50.74	21.79	
22	29.19	.....	28.06	.....	24.38	.....	14.27	.....	20.93	.....	22
					35.11	.....	25.24	.....	30.13	.....	
23	37.68	7.71	49.51	19.90	48.13	22.78	38.58	23.24	42.23	20.36	23
					59.01	23.64	47.79	21.91	52.34	22.12	
24	40.51	9.75	49.44	18.27	48.32	22.00	36.65	20.24	40.84	18.05	24
					57.71	22.08	48.97	22.46	53.01	22.70	
25	31.54	.....	32.72	.....	27.29	.....	17.48	.....	23.73	.....	25
					35.89	.....	27.15	.....	30.41	.....	
26	39.14	6.22	50.31	17.30	46.87	18.90	31.86	14.08	42.34	18.83	26
					55.69	19.48	38.68	11.36	48.53	18.32	
27	40.61	6.29	53.25	19.96	47.31	18.65	38.06	19.99	41.90	18.61	27
					54.35	17.82	44.76	17.26	47.36	17.34	
28	35.71	.....	33.58	.....	29.34	.....	18.36	.....	23.07	.....	28
					36.85	.....	27.66	.....	29.82	.....	
29	43.89	8.18	53.36	19.78	48.92	19.58	37.36	19.00	38.93	15.86	29
					53.73	16.88	40.07	12.41	48.12	18.30	
30	41.73	6.02	46.51	12.93	53.27	23.93	45.32	26.96	41.90	18.83	30
					56.46	19.61	46.37	18.71	45.97	16.15	
O	31.89	.....	30.82	.....	27.07	.....	16.46	.....	21.37	.....	O
					35.01	.....	24.20	.....	28.02	.....	
F	38.75	6.86	46.09	15.27	45.78	18.71	33.89	17.43	38.56	17.19	F
					52.34	17.33	41.30	17.10	45.95	17.93	

TABLE 21.—Yield and increase of CORN grown in 5-year rotation at Wooster—Bushels per acre Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919–1923 Yield	1919–1923 Increase	1894–1923 Yield	1894–1923 Increase	Treatment on corn Fertilizing materials—pounds per acre		Plot No.
1	18.46	.....	24.36	.....	None	East..	1
	33.25	.....	.....	.....	None	West..	
2	24.06	6.48	31.78	7.74	Acid phosphate, 80	East..	2
	34.48	2.51	.....	.....	Acid phosphate, 80	West..	
3	22.25	5.55	29.20	5.48	Muriate potash, 80	East..	3
	47.16	16.47	.....	.....	Muriate potash, 80	West..	
4	15.83	.....	23.40	.....	None	East..	4
	29.41	.....	.....	.....	None	West..	
5	22.11	6.00	29.40	5.57	Nitrate soda, 160	East..	5
	35.72	6.42	.....	.....	Nitrate soda, 160	West..	
6	32.47	16.06	39.63	15.37	Acid phosphate, 80; nitrate soda, 160	East..	6
	35.21	6.03	.....	.....	Acid phosphate, 80; nitrate soda, 160	West..	
7	16.70	.....	24.69	.....	None	East..	7
	29.07	.....	.....	.....	None	West..	
8	33.32	17.51	39.55	15.41	Acid phosphate, 80; muriate potash, 80	East..	8
	53.71	24.21	.....	.....	Acid phosphate, 80; muriate potash, 80	West..	
9	24.21	9.30	30.92	7.34	Muriate potash, 80; nitrate soda, 160	East..	9
	50.11	20.21	.....	.....	Muriate potash, 80; nitrate soda, 160	West..	
10	14.02	.....	23.03	.....	None	East..	10
	30.31	.....	.....	.....	None	West..	
11	42.31	27.41	43.86	20.71	Acid phos., 80; mur. pot., 80; nitrate soda, 160	East..	11
	58.67	26.76	.....	.....	Acid phos., 80; mur. pot., 80; nitrate soda, 160	West..	
12	46.56	30.77	45.13	21.86	Acid phos., 80; mur. pot., 80; nitrate soda, 240	East*	12
	62.84	29.31	.....	.....	Acid phos., 80; mur. pot., 80; nitrate soda, 240	West*	
13	16.67	.....	23.39	.....	None	East..	13
	35.14	.....	.....	.....	None	West..	
14	37.09	20.12	40.76	17.72	Acid phos., 80; mur. pot., 80; nitrate soda, 160	East†	14
	51.69	19.00	.....	.....	Acid phos., 80; mur. pot., 80; nitrate soda, 160	West..	
15	24.76	7.49	30.24	7.54	Fertilized on wheat only	East..	15
	38.53	8.29	.....	.....	Fertilized on wheat only	West..	
16	17.57	.....	22.36	.....	None	East..	16
	27.78	.....	.....	.....	None	West..	
17	49.56	32.00	45.04	22.11	Acid phos., 160; mur. pot., 80; nitrate soda, 80	East..	17
	59.59	30.28	.....	.....	Acid phos., 160; mur. pot., 80; nitrate soda, 80	West..	
18	54.10	36.55	51.34	27.84	Yard manure, 8 tons	East..	18
	61.50	30.68	.....	.....	Yard manure, 8 tons	West..	
19	17.54	.....	24.07	.....	None	East..	19
	32.34	.....	.....	.....	None	West..	
20	35.52	19.31	39.32	16.12	Yard manure, 4 tons	East†	20
	50.04	17.71	.....	.....	Yard manure, 4 tons	West†	
21	42.51	27.65	42.55	20.23	Fertilized as 17, but nitrogen in oilmeal	East*	21
	57.26	24.94	.....	.....	Fertilized as 17, but nitrogen in oilmeal	West*	
22	13.53	.....	21.46	.....	None	East..	22
	32.30	.....	.....	.....	None	West..	
23	40.90	26.76	42.48	20.00	Fertilized as 17, but nitrogen in dried blood	East*	23
	58.23	26.55	.....	.....	Fertilized as 17, but nitrogen in dried blood	West*	
24	37.53	22.75	41.75	18.25	Fertilized as 17, but nitrogen in sulphate ammonia	East..	24
	61.25	30.19	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West..	
25	15.40	.....	24.52	.....	None	East..	25
	30.44	.....	.....	.....	None	West..	
26	35.44	19.66	41.00	15.93	Fertilized as 11, but phosphorus in bonemeal	East..	26
	54.34	23.92	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West..	
27	42.27	26.12	43.89	18.29	Fertilized as 17, but nitrogen in nitrate of lime	East..	27
	57.09	26.68	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West..	
28	16.53	.....	26.16	.....	None	East..	28
	30.39	.....	.....	.....	None	West..	
29	45.55	29.02	44.83	18.66	Fertilized as 11, but phosphorus in basic slag	East..	29
	55.72	25.33	.....	.....	Fertilized as 11, but phosphorus in basic slag	West..	
30	41.41	24.88	44.74	18.58	Fertilized as 17, but nitrogen in tankage	East*	30
	48.67	18.28	.....	.....	Fertilized as 17, but nitrogen in tankage	West*	
O	16.22	.....	23.76	.....	Average unfertilized yields	East..	O
	31.04	.....	.....	.....	Average unfertilized yields	West..	
F	36.70	20.48	39.55	16.04	Average fertilized yields	East..	F
	51.58	20.54	.....	.....	Average fertilized yields	West..	

TABLE 22.—Yield and increase of CORN STOVER grown in 5-year rotation at Wooster—Pounds per acre
Averaged by 5-year periods and for total period of 30 years

Plot No.	1894-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	1,614	.....	1,574	.....	1,670	.....	1,465	.....	1,226	.....	1
					1,953	.....	1,705	.....	1,442	.....	
2	1,622	3	1,828	287	2,125	444	1,580	147	1,433	203	2
					2,317	340	1,835	172	1,626	196	
3	1,696	73	1,824	315	2,082	390	1,655	253	1,554	319	3
					2,420	417	1,960	338	1,786	368	
4	1,628	.....	1,476	.....	1,703	.....	1,370	.....	1,238	.....	4
					2,028	.....	1,580	.....	1,406	.....	
5	1,674	59	1,726	250	1,968	226	1,550	188	1,550	264	5
					2,228	205	1,800	205	1,762	329	
6	1,818	217	1,988	512	2,116	338	1,625	271	1,754	420	6
					2,376	358	1,965	355	1,914	455	
7	1,588	.....	1,476	.....	1,816	.....	1,345	.....	1,382	.....	7
					2,014	.....	1,625	.....	1,486	.....	
8	1,832	285	2,046	585	2,614	826	1,915	555	1,862	516	8
					2,722	722	2,135	492	2,162	657	
9	1,666	161	1,774	329	2,229	469	1,870	495	1,654	344	9
					2,320	336	2,075	413	1,966	443	
10	1,464	.....	1,430	.....	1,732	.....	1,390	.....	1,274	.....	10
					1,970	.....	1,680	.....	1,542	.....	
11	1,821	323	2,180	733	2,772	1,029	1,975	650	1,998	711	11
					2,859	856	2,485	853	2,294	725	
12	1,824	293	2,274	809	2,641	887	2,065	805	1,874	573	12
					2,864	828	2,345	762	2,338	743	
13	1,564	.....	1,482	.....	1,765	.....	1,195	.....	1,314	.....	13
					2,069	.....	1,535	.....	1,622	.....	
14	1,924	340	2,166	691	2,351	600	1,945	730	1,886	578	14
					2,712	665	2,045	535	2,074	483	
15	1,690	138	1,696	229	2,057	322	1,500	265	1,570	266	15
					2,266	244	1,850	365	1,762	201	
16	1,622	.....	1,460	.....	1,719	.....	1,255	.....	1,298	.....	16
					2,000	.....	1,460	.....	1,530	.....	
17	1,802	165	2,222	728	2,607	865	2,115	817	1,934	621	17
					2,865	807	2,200	688	2,230	708	
18	2,060	407	2,272	744	2,719	955	2,495	1,156	2,242	915	18
					3,060	944	2,650	1,086	2,590	1,076	
19	1,668	.....	1,562	.....	1,787	.....	1,380	.....	1,342	.....	19
					2,174	.....	1,615	.....	1,506	.....	
20	1,930	300	2,016	489	2,419	642	1,890	512	1,826	503	20
					2,727	547	2,215	570	2,118	573	
21	1,884	292	2,162	669	2,547	779	1,955	578	1,938	633	21
					2,879	693	2,370	695	2,238	655	
22	1,554	.....	1,458	.....	1,758	.....	1,376	.....	1,286	.....	22
					2,192	.....	1,705	.....	1,622	.....	
23	1,854	265	2,226	721	2,516	727	1,985	590	1,918	590	23
					2,850	682	2,375	652	2,290	649	
24	1,988	363	2,230	679	2,445	626	1,845	430	1,870	498	24
					2,842	697	2,475	733	2,306	647	
25	1,660	.....	1,598	.....	1,850	.....	1,435	.....	1,414	.....	25
					2,122	.....	1,760	.....	1,678	.....	
26	2,010	314	2,256	628	2,513	641	1,940	506	2,046	635	26
					2,871	741	2,195	465	2,210	548	
27	1,946	214	2,386	728	2,439	545	2,080	648	1,899	489	27
					2,738	602	2,300	600	2,170	524	
28	1,768	.....	1,688	.....	1,916	.....	1,430	.....	1,406	.....	28
					2,145	.....	1,670	.....	1,630	.....	
29	2,100	332	2,380	692	2,681	764	2,105	675	1,970	564	29
					2,806	661	2,255	585	2,218	588	
30	1,892	124	2,166	478	2,546	630	2,150	720	2,006	600	30
					2,746	601	2,280	610	2,218	588	
O	1,613	.....	1,520	.....	1,772	.....	1,364	.....	1,318	.....	O
					2,067	.....	1,633	.....	1,546	.....	
F	1,851	238	2,091	571	2,468	696	1,912	548	1,839	521	F
					2,673	606	2,190	557	2,114	568	

TABLE 22.—Yield and increase of CORN STOVER grown in 5-year rotation at Wooster—Pounds per acre Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919–1923 Yield	1919–1923 Increase	1894–1923 Yield	1894–1923 Increase	Treatment on corn* Fertilizing materials—pounds per acre		Plot No.
1	1,060	.....	1,424	.....	None	East..	1
	1,500	.....	.....	.....	None	West..	
2	1,208	188	1,620	210	Acid phosphate, 80	East..	2
	1,572	109	.....	.....	Acid phosphate, 80	West..	
3	1,284	304	1,669	273	Muriate potash, 80	East..	3
	1,796	368	.....	.....	Muriate potash, 80	West..	
4	940	.....	1,382	.....	None	East..	4
	1,392	.....	.....	.....	None	West..	
5	1,128	197	1,585	193	Nitrate soda, 160	East..	5
	1,548	151	.....	.....	Nitrate soda, 160	West..	
6	1,392	471	1,775	376	Acid phosphate, 80; nitrate soda, 160	East..	6
	1,580	177	.....	.....	Acid phosphate, 80; nitrate soda, 160	West..	
7	912	.....	1,407	.....	None	East..	7
	1,408	.....	.....	.....	None	West..	
8	1,452	552	1,942	553	Acid phosphate, 80; muriate potash, 80	East..	8
	1,952	548	.....	.....	Acid phosphate, 80; muriate potash, 80	West..	
9	1,248	360	1,728	358	Muriate potash, 80; nitrate soda, 160	East..	9
	1,876	476	.....	.....	Muriate potash, 80; nitrate soda, 160	West..	
10	876	.....	1,351	.....	None	East..	10
	1,396	.....	.....	.....	None	West..	
11	1,652	756	2,059	700	Acid phos., 80; muriate potash, 80; nitrate soda, 160	East..	11
	2,056	624	.....	.....	Acid phos., 80; muriate potash, 80; nitrate soda, 160	West..	
12	1,780	864	2,065	697	Acid phos., 80; muriate potash, 80; nitrate soda, 240	East..	12
	2,164	696	.....	.....	Acid phos., 80; muriate potash, 80; nitrate soda, 240	West..	
13	936	.....	1,376	.....	None	East..	13
	1,504	.....	.....	.....	None	West..	
14	1,436	477	1,941	562	Acid phos., 80; muriate potash, 80; nitrate soda, 160	East..	14
	1,900	449	.....	.....	Acid phos., 80; muriate potash, 80; nitrate soda, 160	West..	
15	1,196	215	1,619	239	Fertilizer on wheat only	East..	15
	1,564	167	.....	.....	Fertilizer on wheat only	West..	
16	1,004	.....	1,382	.....	None	East..	16
	1,344	.....	.....	.....	None	West..	
17	1,776	767	2,060	655	Acid phos., 160; muriate potash, 80; nitrate soda, 80	East..	17
	2,132	741	.....	.....	Acid phos., 160; muriate potash, 80; nitrate soda, 80	West..	
18	1,920	905	2,264	837	Yard manure, 8 tons	East..	18
	2,248	811	.....	.....	Yard manure, 8 tons	West..	
19	1,020	.....	1,449	.....	None	East..	19
	1,484	.....	.....	.....	None	West..	
20	1,484	520	1,913	490	Yard manure, 4 tons	East..	20
	1,896	436	.....	.....	Yard manure, 4 tons	West..	
21	1,600	692	2,012	615	Fertilized as 17, but nitrogen in oilmeal	East..	21
	2,048	612	.....	.....	Fertilized as 17, but nitrogen in oilmeal	West..	
22	852	.....	1,370	.....	None	East..	22
	1,412	.....	.....	.....	None	West..	
23	1,484	612	1,986	583	Fertilized as 17, but nitrogen in dried blood	East..	23
	2,132	720	.....	.....	Fertilized as 17, but nitrogen in dried blood	West.	
24	1,512	620	1,970	533	Fertilized as 17, but nitrogen in sulphate ammonia	East..	24
	2,140	728	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West..	
25	912	.....	1,470	.....	None	East..	25
	1,412	.....	.....	.....	None	West..	
26	1,556	617	2,059	566	Fertilized as 11, but phosphorus in bonemeal	East..	26
	1,952	535	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West..	
27	1,640	675	2,051	536	Fertilized as 17, but nitrogen in nitrate of lime	East..	27
	2,104	681	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West..	
28	992	.....	1,538	.....	None	East..	28
	1,428	.....	.....	.....	None	West..	
29	1,688	696	2,157	618	Fertilized as 11, but phosphorus in basic slag	East..	29
	1,996	568	.....	.....	Fertilized as 11, but phosphorus in basic slag	West..	
30	1,516	524	2,046	508	Fertilized as 17, but nitrogen in tankage	East..	30
	1,900	472	.....	.....	Fertilized as 17, but nitrogen in tankage	West..	
O	950	.....	1,415	.....	Average unfertilized yields	East..	O
	1,428	.....	.....	.....	Average unfertilized yields	West..	
F	1,498	548	1,926	.....	Average fertilized yields	East..	F
	1,928	500	.....	.....	Average fertilized yields	West..	

*See note page 299.

TABLE 23.—Yield and increase of OATS grown in 5-year rotation at Wooster—Bushels per acre
Averaged by 5-year periods and for total period of 30 years

Plot No.	1894-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	32.20	.....	28.32	.....	36.81	.....	27.81	.....	37.97	....	1
					37.68	.....	26.56	.....	45.03	.....	
2	37.63	5.34	37.37	8.66	44.41	9.82	36.59	10.12	49.34	13.33	2
					47.03	10.00	38.74	12.40	54 75	10.66	
3	34.81	2.32	33.70	4.62	36.87	4.52	26.75	1.62	38.19	4.14	3
					39.81	3.42	30.16	4.03	45.78	2.65	
4	32.48	.....	29.47	.....	30.13	.....	23.78	.....	32.09	.....	4
					35.75	.....	25.91	.....	42.19	.....	
5	35.40	3.11	34.89	5.95	34.97	4.12	28.72	4.63	40.19	7.00	5
					39.13	3.39	29.50	3.07	48.97	6.59	
6	40.36	8.26	48.75	20.32	49.91	13.32	41.79	17.40	57.97	23.69	6
					50.90	15.17	43.47	16.52	59.28	16.72	
7	31.90	.....	27.90	.....	32.31	.....	24.69	.....	35.37	.....	7
					35.72	.....	27.47	.....	42.75	.....	
8	38.26	6.87	40.92	12.72	46.84	13.54	41.65	17.32	50.56	15.55	8
					50.87	15.09	43.03	16.33	58.25	14.54	
9	33.36	2.46	35.75	7.26	38.29	4.00	34.31	10.33	41.34	6.70	9
					40.90	5.06	36.69	10.77	53.56	8.90	
10	30.39	.....	28.78	.....	35.28	.....	23.63	.....	34.28	.....	10
					35.91	.....	25.16	.....	45.62	.....	
11	43.61	12.92	52.48	23.74	54.44	19.80	46.56	22.52	57.59	23.34	11
					52.53	16.99	44.66	18.92	64.47	18.40	
12	45.11	14.11	52.37	23.65	51.47	17.48	46.28	21.82	57.00	22.78	12
					52.09	16.73	47.25	20.93	63.47	16.95	
13	31.30	.....	28.68	.....	33.34	.....	24.87	.....	34.19	.....	13
					35.09	.....	26.90	.....	46.97	.....	
14	36.79	6.19	37.18	9.23	41.51	8.39	35.91	11.00	49.81	15.66	14
					43.84	9.47	36.81	10.35	53.88	8.28	
15	30.31	.41	30.25	3.02	35.37	2.48	28.99	4.04	40.59	6.49	15
					37.55	3.90	30.44	4.43	47.81	3.59	
16	29.20	.....	26.50	... .	32.65	.....	25.00	.....	34.06	.....	16
					32.94	.....	25.56	.....	42.84	.....	
17	38.03	8.57	49.19	22.21	55.43	22.57	49.88	24.53	62.06	27.23	17
					54.50	20.86	49.16	22.73	65.78	22.04	
18	36.91	7.20	40.36	12.90	45.81	12.74	41 50	15.81	56.24	20.64	18
					46.59	12.24	42.37	15.04	58.09	13.46	
19	29.97	.....	27.93	.....	33.28	.....	26.03	.....	36.37	.....	19
					35.06	.....	28.22	.....	45.53	.....	
20	32.39	2.58	36.45	9.05	41.56	8.49	34.81	8.97	48.19	12.55	20
					42.44	7.44	37.87	9.81	52.66	6.97	
21	37.43	7.78	50.64	23.78	51.56	18.70	46.13	20.48	57.41	22.51	21
					54.16	19.22	47.87	19.90	64.00	18.15	
22	29.50	.....	26.33	.....	32.66	.....	25.45	.....	34.15	.....	22
					34.88	.....	27.75	.....	46.00	.....	
23	39.81	9.94	48.67	21.75	52.31	19.19	46.43	20.98	58.12	23.49	23
					51.81	16.38	48.40	20.27	64.19	17.88	
24	43.01	12.76	49.29	21.79	52.09	18.50	44.87	19.41	61.91	26.79	24
					52.94	16.96	50.12	21.60	63.84	17.24	
25	30.62	.....	28.09	.....	34.06	.....	25.47	.....	35.59	.....	25
					36.54	.....	28.90	.....	46.91	.....	
26	43.04	12.11	47.11	18.00	50.19	16.04	42.31	15.99	58.78	22.27	26
					49.78	13.61	42.99	14.05	60.00	12.42	
27	43.54	12.29	51.59	21.48	53.18	18.95	45.59	18.42	60.78	23.36	27
					52.66	16.85	43.94	14.95	64.03	15.77	
28	31.56	.....	31.12	.....	34.31	.....	28.03	.....	38.34	.....	28
					35.43	.....	29.03	.....	48.94	.....	
29	42.49	10.93	49.19	18.07	50.56	16.25	43.34	15.31	60.68	22.34	29
					50.59	15.16	41.65	12.62	62.09	13.15	
30	35.47	3.91	45.78	14.66	52.10	17.79	45.91	17.88	59.34	21.00	30
					47.57	12.14	45.13	16.10	64.31	15.37	
O	30.91	.....	28.30	.....	33.48	.....	25.48	.....	35.24	....	O
					35.50	.....	27.15	.....	45.28	.....	
F	38.38	7.47	43.60	15.26	46.94	13.46	40.40	14.92	53.30	18.06	F
					47.89	12.39	41.51	14.36	58.47	13.19	

TABLE 23.—Yield and increase of OATS grown in 5-year rotation at Wooster—Bushels per acre Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919-1923 Yield	1919-1923 Increase	1894-1923 Yield	1894-1923 Increase	Treatment for oats* Fertilizing materials—pounds per acre		Plot No.
1	21.44	.....	30.54	.....	None	East..	1
	32.75	.....	.....	.....	None	West..	
2	30.37	9.24	39.21	9.58	Acid phosphate, 80	East..	2
	35.53	3.33	.....	.....	Acid phosphate, 80	West..	
3	26.00	5.17	32.44	3.74	Muriate potash, 80	East..	3
	37.91	6.26	.....	.....	Muriate potash, 80	West..	
4	20.53	.....	27.79	.....	None	East..	4
	31.09	.....	.....	.....	None	West..	
5	24.97	4.11	32.88	4.77	Nitrate soda, 160	East..	5
	37.06	5.91	.....	.....	Nitrate soda, 160	West..	
6	40.03	18.85	46.49	18.06	Acid phosphate, 80; nitrate soda, 160	East..	6
	41.66	10.46	.....	.....	Acid phosphate, 80; nitrate soda, 160	West..	
7	21.52	.....	28.75	.....	None	East..	7
	31.25	.....	.....	.....	None	West..	
8	37.37	15.75	42.47	13.67	Acid phosphate, 80; muriate potash, 80	East..	8
	45.91	15.15	.....	.....	Acid phosphate, 80; muriate potash, 80	West..	
9	27.97	6.25	35.10	6.27	Muriate potash, 80; nitrate soda, 160	East..	9
	39.40	9.14	.....	.....	Muriate potash, 80; nitrate soda, 160	West..	
10	21.81	.....	28.87	.....	None	East..	10
	29.78	.....	.....	.....	None	West..	
11	43.66	21.54	49.74	20.81	Acid phos., 80; muriate potash, 80; nitrate soda, 160	East..	11
	45.65	14.87	.....	.....	Acid phos., 80; muriate potash, 80; nitrate soda, 160	West..	
12	48.37	25.94	50.08	21.10	Acid phos., 80; muriate potash, 80; nitrate soda, 240	East..	12
	46.31	14.49	.....	.....	Acid phos., 80; muriate potash, 80; nitrate soda, 240	West..	
13	22.75	.....	29.04	.....	None	East..	13
	32.84	.....	.....	.....	None	West..	
14	36.90	14.00	39.52	10.71	Fertilizer on corn and wheat only	East..	14
	38.78	6.34	.....	.....	Fertilizer on corn and wheat only	West..	
15	29.92	6.88	33.15	4.58	Fertilizer on wheat only	East..	15
	35.34	3.31	.....	.....	Fertilizer on wheat only	West..	
16	23.22	.....	28.34	.....	None	East..	16
	31.62	.....	.....	.....	None	West..	
17	50.69	26.78	50.85	22.08	Acid phos., 160; muriate potash, 80; nitrate soda, 80	East..	17
	48.31	15.71	.....	.....	Acid phos., 160; muriate potash, 80; nitrate soda, 80	West..	
18	42.22	17.62	43.73	14.54	Yard manure on corn and wheat only	East..	18
	44.15	10.57	.....	.....	Yard manure on corn and wheat only	West..	
19	25.28	.....	29.61	.....	None	East..	19
	34.56	.....	.....	.....	None	West..	
02	37.22	12.59	38.23	9.02	Yard manure on corn and wheat only	East..	20
	40.31	6.24	.....	.....	Yard manure on corn and wheat only	West..	
12	47.84	23.87	48.35	19.53	Fertilized as 17, but nitrogen in oilmeal	East..	21
	47.47	13.89	.....	.....	Fertilized as 17, but nitrogen in oilmeal	West..	
22	23.31	.....	28.42	.....	None	East..	22
	33.09	.....	.....	.....	None	West..	
23	46.84	23.00	48.68	19.84	Fertilized as 17, but nitrogen in dried blood	East..	23
	48.72	15.54	.....	.....	Fertilized as 17, but nitrogen in dried blood	West..	
24	46.87	22.49	49.55	20.29	Fertilized as 17, but nitrogen in sulphate ammonia	East..	24
	45.62	12.36	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West..	
25	24.91	.....	29.66	.....	None	East..	25
	33.34	.....	.....	.....	None	West..	
26	43.88	20.00	47.55	17.50	Fertilized as 11, but phosphorus in bonemeal	East..	26
	43.44	10.00	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West..	
27	45.50	22.61	50.05	19.60	Fertilized as 17, but nitrogen in nitrate of lime	East..	27
	46.81	13.28	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West..	
28	21.87	.....	30.84	.....	None	East..	28
	33.63	.....	.....	.....	None	West..	
29	43.66	21.79	48.37	17.53	Fertilized as 11, but phosphorus in basic slag	East..	29
	44.81	11.18	.....	.....	Fertilized as 11, but phosphorus in basic slag	West..	
30	40.09	18.22	46.45	15.62	Fertilized as 17, but nitrogen in tankage	East..	30
	42.84	9.21	.....	.....	Fertilized as 17, but nitrogen in tankage	West..	
O	22.66	.....	29.21	.....	Average unfertilized yields	East..	O
	32.41	.....	.....	.....	Average unfertilized yields	West..	
F	39.52	16.86	45.04	.....	Average fertilized yields	East..	F
	42.80	10.39	.....	.....	Average fertilized yields	West..	

*See note page 299.

TABLE 24.—Yield and increase of OAT STRAW grown in 5-year rotation at Wooster—Pounds per acre
Averaged by 5-year periods and for total period of 30 years

Plot No.	1894-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	1,233	.....	1,120	.....	1,523	.....	1,214	.....	1,491	.....	1
					1,700	.....	1,410	.....	1,945	.....	
2	1,341	83	1,452	345	1,787	320	1,813	664	1,980	520	2
					2,111	476	1,848	472	2,444	606	
3	1,287	3	1,211	117	1,538	126	1,140	56	1,625	197	3
					1,782	213	1,555	214	1,974	241	
4	1,309	.....	1,080	.....	1,356	.....	1,019	.....	1,397	.....	4
					1,504	.....	1,307	.....	1,626	.....	
5	1,315	35	1,337	285	1,511	158	1,221	158	1,638	227	5
					1,726	186	1,434	100	2,069	379	
6	1,549	299	1,778	752	2,067	718	2,043	937	2,469	1,043	6
					2,363	786	2,267	905	2,522	768	
7	1,221	.....	998	.....	1,346	.....	1,150	.....	1,441	.....	7
					1,613	.....	1,389	.....	1,820	.....	
8	1,479	277	1,514	525	2,055	641	1,999	870	2,248	894	8
					2,418	740	2,331	984	2,671	901	
9	1,299	113	1,336	355	1,658	177	1,822	713	1,659	394	9
					2,003	260	2,214	909	2,285	568	
10	1,167	.....	973	.....	1,549	.....	1,088	.....	1,178	.....	10
					1,808	.....	1,263	.....	1,669	.....	
11	1,809	609	1,989	993	2,660	1,118	2,622	1,526	2,669	1,426	11
					2,676	914	2,397	1,086	3,101	1,370	
12	1,952	721	2,220	1,202	2,493	959	2,247	1,143	2,414	1,109	12
					2,709	992	2,643	1,283	2,888	1,093	
13	1,263	.....	1,040	.....	1,527	.....	1,112	.....	1,369	.....	13
					1,671	.....	1,407	.....	1,857	.....	
14	1,524	298	1,420	410	2,021	539	1,623	506	1,987	619	14
					2,005	422	1,742	389	2,271	491	
15	1,138	−64	1,098	120	1,610	172	1,276	153	1,542	175	15
					1,722	226	1,476	177	1,825	123	
16	1,151	.....	948	.....	1,397	.....	1,128	.....	1,364	.....	16
					1,408	.....	1,246	.....	1,625	.....	
17	1,552	410	1,996	1,020	2,750	1,314	2,652	1,458	2,976	1,575	17
					2,908	1,406	2,963	1,661	3,216	1,555	
18	1,451	316	1,636	636	2,372	896	2,132	933	2,351	914	18
					2,487	891	2,428	1,071	2,709	1,009	
19	1,127	.....	1,026	.....	1,517	.....	1,235	.....	1,472	.....	19
					1,690	.....	1,413	.....	1,738	.....	
20	1,315	174	1,355	366	1,974	496	1,614	413	1,870	482	20
					2,046	391	2,056	616	2,289	538	
21	1,560	404	2,057	1,103	2,480	1,039	2,573	1,408	2,466	1,162	21
					2,681	1,061	2,246	778	2,862	1,098	
22	1,170	.....	918	.....	1,403	.....	1,133	.....	1,220	.....	22
					1,584	.....	1,495	.....	1,777	.....	
23	1,434	223	1,993	1,030	2,566	1,113	2,522	1,337	2,548	1,319	23
					2,630	1,023	2,431	923	3,086	1,327	
24	1,791	540	2,140	1,134	2,623	1,121	2,556	1,319	2,538	1,300	24
					2,836	1,206	2,848	1,326	2,979	1,238	
25	1,292	.....	1,051	.....	1,552	.....	1,289	.....	1,247	.....	25
					1,653	.....	1,535	.....	1,723	.....	
26	1,604	341	1,905	837	2,398	870	2,198	887	2,516	1,210	26
					2,407	797	2,333	821	2,684	962	
27	1,724	490	2,035	952	2,709	1,208	2,429	1,096	2,667	1,297	27
					2,750	1,187	2,734	1,244	2,787	1,066	
28	1,206	.....	1,100	.....	1,476	.....	1,355	.....	1,431	.....	28
					1,518	.....	1,467	.....	1,720	.....	
29	1,678	472	1,850	750	2,544	1,068	2,357	1,002	2,911	1,480	29
					2,471	953	2,014	547	2,815	1,095	
30	1,343	137	1,739	639	2,503	1,027	2,251	896	2,523	1,092	30
					2,352	834	2,315	848	2,874	1,154	
O	1,214	.....	1,025	.....	1,464	.....	1,172	.....	1,361	.....	O
					1,615	.....	1,393	.....	1,907	.....	
F	1,507	293	1,703	678	2,216	752	2,055	883	2,280	919	F
					2,354	739	2,193	800	2,764	857	

TABLE 24.—Yield and increase of OAT STRAW grown in 5-year rotation at Wooster—Pounds per acre Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919-1923 Yield	1919-1923 Increase	1894-1923 Yield	1894-1923 Increase	Treatment for oats* Fertilizing materials—pounds per acre		Plot No.
1	1,038	.....	1,258	.....	None	East..	1
	1,660	.....	.....	.....	None	West..	
2	1,184	230	1,587	365	Acid phosphate, 80	East..	2
	1,883	285	.....	.....	Acid phosphate, 80	West..	
3	1,040	169	1,293	110	Muriate potash, 80	East..	3
	1,795	260	.....	.....	Muriate potash, 80	West..	
4	787	.....	1,144	.....	None	East..	4
	1,473	.....	.....	.....	None	West..	
5	1,053	236	1,335	185	Nitrate soda, 160	East..	5
	1,846	382	.....	.....	Nitrate soda, 160	West..	
6	1,767	919	1,938	782	Acid phosphate, 80; nitrate soda, 160	East..	6
	2,067	613	.....	.....	Acid phosphate, 80; nitrate soda, 160	West..	
7	878	.....	1,161	.....	None	East..	7
	1,444	.....	.....	.....	None	West..	
8	1,692	821	1,826	676	Acid phosphate, 80; muriate potash, 80	East..	8
	2,167	705	.....	.....	Acid phosphate, 80; muriate potash, 80	West..	
9	1,113	248	1,477	338	Muriate potash, 80; nitrate soda, 160	East..	9
	2,079	598	.....	.....	Muriate potash, 80; nitrate soda, 160	West..	
10	858	.....	1,129	.....	None	East..	10
	1,499	.....	.....	.....	None	West..	
11	2,095	1,179	2,309	1,151	Acid phos., 80; muriate potash, 80; nitrate soda, 160	East..	11
	2,635	1,068	.....	.....	Acid phos., 80; muriate potash, 80; nitrate soda, 160	West..	
12	2,280	1,306	2,271	1,084	Acid phos., 80; muriate potash, 80; nitrate soda, 240	East..	12
	2,642	1,004	.....	.....	Acid phos,, 80; muriate potash, 80; nitrate soda, 240	West..	
13	1,032	.....	1,216	.....	None	East..	13
	1,705	.....	.....	.....	None	West..	
14	1,543	540	1,681	487	Fertilizer on corn and wheat only	East..	14
	2,079	445	.....	.....	Fertilizer on corn and wheat only	West..	
15	1,186	212	1,343	171	Fertilizer on wheat only	East..	15
	1,613	50	.....	.....	Fertilizer on wheat only	West..	
16	944	.....	1,150	.....	None	East..	16
	1,492	.....	.....	.....	None	West..	
17	2,406	1,444	2,392	1,218	Acid phos., 160; muriate potash, 80; nitrate soda, 80	East..	17
	2,618	1,093	.....	.....	Acid phos., 160; muriate potash, 80; nitrate soda, 80	West .	
18	2,057	1,076	2,011	814	Yard manure on corn and wheat only	East..	18
	2,423	866	.....	.....	Yard manure on corn and wheat only	West..	
19	999	.....	1,221	.....	None	East..	19
	1,590	.....	.....	.....	None	West..	
20	1,505	509	1,594	402	Yard manure on corn and wheat only	East..	20
	1,902	313	.....	.....	Yard manure on corn and wheat only	West..	
21	2,201	1,208	2,219	1,056	Fertilized as 17, but nitrogen in oilmeal	East..	21
	2,517	930	.....	.....	Fertilized as 17, but nitrogen in olimeal	West..	
22	988	.....	1,134	.....	None	East..	22
	1,585	.....	.....	.....	None	West..	
23	2,117	1,110	2,199	1,028	Fertilized as 17, but nitrogen in dried blood	East..	23
	2,387	796	.....	.....	Fertilized as 17, but nitrogen in dried blood	West..	
24	2,236	1,210	2,313	1,106	Fertilized as 17, but nitrogen in sulphate ammonia	East..	24
	2,436	837	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West..	
25	1,043	.....	1,244	.....	None	East..	25
	1,609	.....	.....	.....	None	West..	
26	2,086	1,087	2,126	880	Fertilized as 11, but phosphorus in bonemeal	East..	26
	2,282	743	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West..	
27	2,188	1,230	2,296	1,048	Fertilized as 17, but nitrogen in nitrate of lime	East..	27
	2,226	756	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West..	
28	916	.....	1,250	.....	None	East..	28
	1,400	.....	.....	.....	None	West..	
29	2,163	1,247	2,257	1,007	Fertilized as 11, but phosphorus in basic slag	East..	29
	2,346	946	.....	.....	Fertilized as 11, but phosphorus in basic slag	West..	
30	1,833	917	2,033	783	Fertilized as 17, but nitrogen in tankage	East..	30
	2,173	773	.....	.....	Fertilized as 17, but nitrogen in tankage	West..	
O	948	.....	1,191	.....	Average unfertilized yields	East..	O
	1,546	.....	.....	.....	Average unfertilized yields	West..	
F	1,797	849	1,918	.....	Average fertilized yields	East..	F
	2,206	660	.....	.....	Average fertilized yields	West..	

*See note page 299.

TABLE 25.—Yield and increase of WHEAT grown in 5-year rotation at Wooster—Bushels per acre
Averaged by 5-year periods and for total period of 30 years

Plot No.	1894–1898		1899–1903		1904–1908		1909–1913		1914–1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	8.79	.....	9.03	.....	12.73	.....	11.53	.....	13.70	.....	1
					14.14	.....	13.70	.....	16.32	.....	
2	12.35	3.14	18.67	9.81	22.93	10.13	17.63	6.36	21.77	8.88	2
					25.33	10.95	20.48	7.26	26.18	10.21	
3	11.26	1.64	9.54	.86	14.31	1.43	11.20	.19	12.90	.83	3
					15.92	1.30	12.88	.14	17.80	2.17	
4	10.03	.....	8.50	.....	12.94	.....	10.75	.....	11.25	.....	4
					14.86	.....	12.27	.....	15.28	.....	
5	11.57	1.54	10.58	2.10	15.57	2.67	12.82	2.27	13.30	1.79	5
					16.75	1.80	13.23	1.00	17.90	1.74	
6	16.84	6.81	24.46	16.00	30.53	17.69	23.13	12.78	28.80	17.03	6
					31.20	16.14	25.28	13.10	32.17	15.12	
7	10.02	.....	8.45	.....	12.80	.....	10.15	.....	12.03	.....	7
					15.15	.....	12.15	.....	17.93	.....	
8	15.20	5.22	19.78	11.31	22.22	9.40	19.45	8.83	22.13	10.64	8
					25.71	10.73	20.17	8.08	30.11	12.36	
9	12.09	2.15	11.12	2.61	16.72	3.86	13.03	1.94	14.15	3.19	9
					17.90	3.09	14.97	2.94	20.52	2.95	
10	9.89	.....	8.53	.....	12.89	.....	11.57	.....	10.42	.....	10
					14.64	.....	11.97	.....	17.40	.....	
11	20.53	10.73	27.47	18.82	32.93	20.02	26.50	15.54	31.67	21.31	11
					33.28	18.61	26.35	14.17	34.45	17.04	
12	20.95	11.23	29.37	20.61	33.58	20.65	24.65	14.28	33.73	23.44	12
					35.58	20.89	27.90	15.51	34.68	17.26	
13	9.63	.....	8.88	.....	12.96	.....	9.76	.....	10.23	.....	13
					14.72	.....	12.60	.....	17.43	.....	
14	18.11	8.92	25.55	17.10	32.37	19.65	23.95	14.39	29.15	18.73	14
					31.85	17.66	23.88	11.75	32.55	15.62	
15	16.77	8.04	24.80	16.80	30.17	17.70	22.20	12.85	28.50	17.89	15
					30.75	17.09	24.17	12.50	32.50	16.06	
16	8.28	.....	7.57	.....	12.23	.....	9.15	.....	10.80	.....	16
					13.13	.....	11.20	.....	15.93	.....	
17	13.84	5.55	23.20	15.39	28.42	15.77	22.04	12.72	29.00	17.67	17
					30.15	16.45	24.97	13.22	34.32	17.79	
18	12.65	4.35	19.02	10.97	29.08	16.00	25.13	15.64	30.35	18.49	18
					30.87	16.59	28.18	15.88	34.58	17.47	
19	8.31	.....	8.28	.....	13.51	.....	9.67	.....	12.40	.....	19
					14.85	.....	12.85	.....	17.70	.....	
20	11.48	3.25	14.67	6.41	23.67	10.55	20.56	10.96	23.58	11.53	20
					25.28	10.48	23.42	10.77	28.07	10.46	
21	18.35	10.20	23.88	15.66	26.95	14.25	22.43	12.89	26.30	14.59	21
					28.95	14.22	23.53	11.08	31.74	14.21	
22	8.07	.....	8.20	.....	12.31	.....	9.47	.....	11.39	.....	22
					14.68	.....	12.25	.....	17.43	.....	
23	16.78	8.14	23.28	14.71	24.91	12.42	20.93	11.26	25.05	13.37	23
					28.04	13.48	23.95	11.49	32.03	14.57	
24	17.85	8.64	22.97	14.02	25.30	12.62	21.10	11.24	26.05	14.05	24
					29.67	15.22	25.40	12.72	33.55	16.05	
25	9.78	.....	9.32	.....	12.87	.....	10.05	.....	12.32	.....	25
					14.33	.....	12.90	.....	17.53	.....	
26	18.17	8.33	24.18	15.07	27.65	14.90	22.77	12.80	29.47	17.18	26
					28.60	14.42	23.50	10.61	28.43	11.18	
27	18.86	8.94	28.72	19.81	31.31	18.67	21.98	12.10	27.72	15.46	27
					31.75	17.73	24.84	11.95	32.15	15.20	
28	9.98	.....	8.70	.....	12.52	.....	9.80	.....	12.23	.....	28
					13.87	.....	12.88	.....	16.67	.....	
29	18.71	8.73	26.58	17.88	30.01	17.49	23.20	13.40	31.70	19.47	29
					27.07	13.20	23.87	10.99	32.43	15.76	
30	14.66	4.68	23.90	15.20	27.44	14.92	22.05	12.25	28.02	15.79	30
	.....	.....	.....	.....	27.24	13.37	21.63	8.75	30.63	13.96	
O	9.28	.....	8.55	.....	12.78	.....	10.19	.....	11.67	.....	O
					14.44	.....	12.48	.....	16.96	.....	
F	15.87	6.59	21.59	13.04	25.80	13.02	20.84	10.65	26.17	14.50	F
	.....	.....	.....	.....	27.69	13.25	22.63	10.15	29.84	12.88	

TABLE 25.—Yield and increase of WHEAT grown in 5-year rotation at Wooster—Bushels per acre
Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919–1923 Yield	1919–1923 Increase	1894–1923 Yield	1894–1923 Increase	Treatment for wheat* Fertilizing materials—pounds per acre		Plot No.
1	9.23	.....	10.83	.....	None	East	1
	15.67	.....	.....	.....	None	West	
2	15.76	7.10	18.18	7.57	Acid phosphate, 160	East	2
	22.00	7.45	.....	.....	Acid phosphate, 160	West	
3	8.02	—.08	11.20	.81	Muriate potash, 100	East	3
	14.88	1.44	.....	.....	Muriate potash, 100	West	
4	7.53	.....	10.17	.....	None	East	4
	12.33	.....	.....	.....	None	West	
5	8.58	.98	12.07	1.89	Nitrate soda, 160	East	5
	14.30	1.67	.....	.....	Nitrate soda, 160	West	
6	19.27	11.59	23.84	13.65	Acid phosphate, 160; nitrate soda, 160	East	6
	25.88	12.95	.....	.....	Acid phosphate, 160; nitrate soda, 160	West	
7	7.75	.....	10.20	.....	None	East	7
	13.23	.....	.....	.....	None	West	
8	15.90	8.20	19.11	8.93	Acid phosphate, 160; muriate potash, 100	East	8
	24.49	11.14	.....	.....	Acid phosphate, 160; muriate potash, 100	West	
9	9.20	1.55	12.72	2.55	Muriate potash, 100; nitrate soda, 160	East	9
	15.32	1.85	.....	.....	Muriate potash, 100; nitrate soda, 160	West	
10	7.60	.....	10.15	.....	None	East	10
	13.59	.....	.....	.....	None	West	
11	21.43	14.18	26.75	16.76	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East	11
	30.33	17.32	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West	
12	24.00	17.09	27.71	17.88	Acid phos., 160; muriate potash, 100; nitrate soda, 240	East	12
	29.02	16.58	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 240	West	
13	6.57	.....	9.67	.....	None	East	13
	11.87	.....	.....	.....	None	West	
14	21.85	15.60	25.16	15.73	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East	14
	26.75	14.98	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West	
15	21.70	15.77	24.02	14.84	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East	15
	25.70	14.04	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West	
16	5.62	.....	8.94	.....	None	East	16
	11.57	.....	.....	.....	None	West	
17	21.37	15.35	22.98	13.74	Acid phos., 160; muriate potash, 100; nitrate soda, 80	East	17
	27.90	15.77	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 80	West	
18	24.63	18.23	23.48	13.95	Yard manure, 8 tons	East	18
	28.87	16.17	.....	.....	Yard manure, 8 tons	West	
19	6.80	.....	9.83	.....	None	East	19
	13.27	.....	.....	.....	None	West	
20	18.33	11.43	18.71	9.02	Yard manure, 4 tons	East	20
	24.95	11.63	.....	.....	Yard manure, 4 tons	West	
21	20.15	13.14	23.01	13.45	Fertilized as 17, but nitrogen in oilmeal	East	21
	26.92	13.54	.....	.....	Fertilized as 17, but nitrogen in oilmeal	West	
22	7.12	.....	9.42	.....	None	East	22
	13.43	.....	.....	.....	None	West	
23	19.55	12.23	21.75	12.02	Fertilized as 17, but nitrogen in dried blood	East	23
	27.50	14.38	.....	.....	Fertilized as 17, but nitrogen in dried blood	West	
24	19.85	12.33	22.18	12.15	Fertilized as 17, but nitrogen in sulphate ammonia	East	24
	28.78	15.97	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West	
25	7.72	.....	10.34	.....	None	East	25
	12.50	.....	.....	.....	None	West	
26	22.65	15.34	24.15	13.93	Fertilized as 11, but phosphorus in bonemeal	East	26
	21.83	9.10	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West	
27	19.77	12.85	24.72	14.64	Fertilized as 17, but nitrogen in nitrate of lime	East	27
	26.45	13.50	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West	
28	6.51	.....	9.96	.....	None	East	28
	13.18	.....	.....	.....	None	West	
29	26.34	19.83	26.09	16.13	Fertilized as 11, but phosphorus in basic slag	East	29
	27.28	14.10	.....	.....	Fertilized as 11, but phosphorus in basic slag	West	
30	20.22	13.79	22.71	12.75	Fertilized as 17, but nitrogen in tankage	East	30
	24.87	11.69	.....	.....	Fertilized as 17, but nitrogen in tankage	West	
	7.24	.....	10.47	.....	Average unfertilized yields	East	O
O	13.06	.....	.....	.....	Average unfertilized yields	West	
	18.99	11.75	22.94	.....	Average fertilized yields	East	F
F	24.77	11.71	.....	.....	Average fertilized yields	West	

*See note page 299.

TABLE 26.—Yield and increase of WHEAT STRAW grown in 5-year rotation at Wooster—Pounds per acre Averaged by 5-year periods and for total period of 30 years

Plot No.	1894-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	941	.....	898	.....	1,376	.....	1,169	.....	1,404	.....	1
					1,702	.....	1,153	.....	1,609	.....	
2	1,417	426	1,756	889	2,214	860	1,756	629	1,945	634	2
					2,550	875	2,026	876	2,509	951	
3	1,226	189	913	79	1,552	222	1,102	21	1,206	—1	3
					1,796	151	1,392	246	1,772	266	
4	1,084	.....	807	.....	1,308	.....	1,037	.....	1,109	.....	4
					1,617	.....	1,143	.....	1,455	.....	
5	1,327	228	1,018	216	1,820	527	1,606	574	1,354	243	5
					2,017	401	1,350	182	1,874	354	
6	2,007	893	2,276	1,475	3,036	1,760	2,495	1,467	2,752	1,640	6
					3,132	1,516	2,730	1,537	3,184	1,601	
7	1,130	.....	801	.....	1,261	.....	1,023	.....	1,114	.....	7
					1,615	.....	1,216	.....	1,650	.....	
8	1,559	465	1,799	999	2,026	741	2,036	991	2,180	1,082	8
					2,405	850	2,078	889	2,845	1,197	
9	1,269	211	1,106	306	1,891	581	1,343	275	1,507	424	9
					2,000	503	1,529	371	2,001	355	
10	1,022	.....	799	.....	1,334	.....	1,090	.....	1,067	.....	10
					1,437	.....	1,129	.....	1,644	.....	
11	2,356	1,331	2,676	1,880	3,422	2,056	3,013	1,959	3,228	2,175	11
					3,566	2,093	2,924	1,795	3,621	1,987	
12	2,433	1,406	2,702	1,910	3,493	2,096	2,993	1,974	3,610	2,570	12
					3,809	2,302	3,090	1,960	3,631	2,007	
13	1,030	.....	789	.....	1,428	.....	984	.....	1,026	.....	13
					1,542	.....	1,130	.....	1,614	.....	
14	2,175	1,196	2,461	1,702	3,194	1,832	2,757	1,777	2,947	1,926	14
					3,345	1,895	2,509	1,408	3,187	1,552	
15	1,943	1,015	2,338	1,609	3,058	1,763	2,484	1,509	3,978	1,961	15
					3,099	1,740	2,577	1,505	3,162	1,507	
16	877	.....	699	.....	1,228	.....	974	.....	1,012	.....	16
					1,266	.....	1,043	.....	1,676	.....	
17	1,545	680	2,162	1,439	2,787	1,471	2,441	1,459	3,002	1,892	17
					3,067	1,698	2,727	1,599	3,617	1,879	
18	1,579	724	1,973	1,227	2,931	1,528	2,947	1,956	3,231	2,019	18
					3,164	1,693	3,074	1,862	3,849	2,049	
19	843	.....	771	.....	1,490	.....	999	.....	1,312	.....	19
					1,573	.....	1,297	.....	1,862	.....	
20	1,359	511	1,564	804	2,404	996	2,217	1,218	2,405	1,134	20
					2,603	1,059	2,350	1,078	2,790	1,017	
21	2,119	1,266	2,261	1,513	2,735	1,409	2,520	1,521	2,718	1,487	21
					2,947	1,432	2,480	1,234	3,280	1,597	
22	858	.....	737	.....	1,243	.....	999	.....	1,190	.....	22
					1,485	.....	1,221	.....	1,594	.....	
23	1,813	908	2,201	1,428	2,363	1,055	2,336	1,313	2,623	1,433	23
					2,729	1,189	2,500	1,238	3,446	1,791	
24	1,917	965	2,156	1,347	2,554	1,180	2,357	1,311	2,745	1,550	24
					2,884	1,289	2,745	1,441	3,415	1,700	
25	999	.....	845	.....	1,438	.....	1,070	.....	1,197	.....	25
					1,650	.....	1,345	.....	1,776	.....	
26	2,085	1,088	2,197	1,376	2,861	1,485	2,629	1,544	2,948	1,748	26
					2,810	1,279	2,558	1,224	2,894	1,151	
27	2,120	1,124	2,631	1,837	3,243	1,933	2,636	1,534	2,857	1,654	27
					3,092	1,680	2,753	1,430	3,183	1,474	
28	995	.....	770	.....	1,246	.....	1,117	.....	1,206	.....	28
					1,293	.....	1,312	.....	1,676	.....	
29	2,095	1,100	2,401	1,631	3,273	2,027	2,754	1,637	3,542	2,336	29
					2,841	1,548	2,386	1,074	3,410	1,734	
30	1,580	585	1,998	1,228	2,770	1,524	2,461	1,344	2,943	1,737	30
					2,788	1,495	2,270	958	3,070	1,394	
O	979	.....	791	.....	1,334	.....	1,048	.....	1,163	.....	O
					1,517	.....	1,199	.....	1,655	.....	
F	1,796	817	2,029	1,238	2,681	1,347	2,344	1,296	2,636	1,473	F
					2,832	1,315	1,402	1,203	3,037	1,382	

TABLE 26.—Yield and increase of WHEAT STRAW grown in 5-year rotation at Wooster—Pounds per acre Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919–1923 Yield	1919–1923 Increase	1894–1923 Yield	1894–1923 Increase	Treatment for wheat* Fertilizing materials—pounds per acre		Plot No.
1	1,159	.....	1,135	.....	None	East..	1
	1,262	.....	.....	.....	None	West..	
2	1,818	688	1,749	658	Acid phosphate, 160	East..	2
	2,052	803	.....	.....	Acid phosphate, 160	West..	
3	1,200	101	1,133	87	Muriate potash, 100	East..	3
	1,420	185	.....	.....	Muriate potash, 100	West..	
4	1,069	.....	1,001	.....	None	East..	4
	1,221	.....	.....	.....	None	West..	
5	1,425	357	1,342	333	Nitrate soda, 160	East..	5
	1,517	276	.....	.....	Nitrate soda, 160	West..	
6	2,513	1,446	2,439	1,421	Acid phosphate, 160; nitrate soda, 160	East..	6
	2,666	1,404	.....	.....	Acid phosphate, 160; nitrate soda, 160	West..	
7	1,066	.....	1,025	.....	None	Easz..	7
	1,283	.....	.....	.....	None	West..	
8	1,920	855	1,846	823	Acid phosphate, 160; muriate potash, 100	East..	8
	2,137	880	.....	.....	Acid phosphate, 160; muriate potash, 100	West..	
9	1,423	360	1,366	347	Muriate potash, 100; nitrate soda, 160	East..	9
	1,581	349	.....	.....	Muriate potash, 100; nitrate soda, 160	West..	
10	1,062	.....	1,016	.....	None	East..	10
	1,206	.....	.....	.....	None	West..	
11	2,939	1,880	2,830	1,824	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East..	11
	3,028	1,817	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West..	
12	3,046	1,991	2,968	1,973	Acid phos., 160; muriate potash, 100; nitrate soda, 240	East..	12
	3,133	1,917	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 240	West..	
13	1,051	.....	984	.....	None	East..	13
	1,221	.....	.....	.....	None	West..	
14	2,707	1,687	2,615	1,662	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East..	14
	2,735	1,551	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West..	
15	2,560	1,571	2,477	1,554	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East..	15
	2,624	1,475	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West..	
16	958	.....	892	.....	None	East..	16
	1,112	.....	.....	.....	None	West..	
17	2,388	1,388	2,322	1,368	Acid phos., 160; muriate potash, 100; nitrate soda, 80	East..	17
	2,624	1,459	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 80	West..	
18	2,532	1,491	2,531	1,551	Yard manure, 8 tons	East..	18
	2,728	1,511	.....	.....	Yard manure, 8 tons	West..	
19	1,085	.....	1,023	.....	None	East..	19
	1,269	.....	.....	.....	None	West..	
20	1,990	933	1,948	952	Yard manure, 4 tons	East..	20
	2,134	894	.....	.....	Yard manure, 4 tons	West..	
21	2,471	1,439	2,372	1,405	Fertilized as 17, but nitrogen in oilmeal	East..	21
	2,617	1,408	.....	.....	Fertilized as 17, but nitrogen in oilmeal	West..	
22	1,005	.....	938	.....	None	East..	22
	1,179	.....	.....	.....	None	West..	
23	2,268	1,228	2,193	1,219	Fertilized as 17, but nitrogen in dried blood	East..	23
	2,538	1,311	.....	.....	Fertilized as 17, but nitrogen in dried blood	West..	
24	2,346	1,271	2,245	1,235	Fertilized as 17, but nitrogen in sulphate ammonia	East..	24
	2,623	1,348	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West..	
25	1,110	.....	1,045	.....	None	East..	25
	1,323	.....	.....	.....	None	West..	
26	2,544	1,448	2,479	1,440	Fertilized as 11, but phosphorus in bonemeal	East..	26
	2,509	1,224	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West..	
27	2,698	1,616	2,565	1,533	Fertilized as 17, but nitrogen in nitrate of lime	East..	27
	2,756	1,509	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West..	
28	1,067	.....	1,025	.....	None	East..	28
	1,209	.....	.....	.....	None	West..	
29	2,813	1,746	2,788	1,762	Fertilized as 11, but phosphorus in basic slag	East..	29
	2,627	1,418	.....	.....	Fertilized as 11, but phosphorus in basic slag	West..	
30	2,350	1,283	2,283	1,258	Fertilized as 17, but nitrogen in tankage	East..	30
	2,341	1,132	.....	.....	Fertilized as 17, but nitrogen in tankage	West..	
O	1,063	.....	1,008	.....	Average unfertilized yields	East..	O
	1,228	.....	.....	.....	Average unfertilized yields	West..	
F	2,296	1,233	2,225	.....	Average fertilized yields	East..	F
	2,426	1,198	.....	.....	Average fertilized yields	West..	

*See note page 299.

TABLE 27.—Yield and increase of CLOVER HAY grown in 5-year rotation at Wooster. Pounds per acre Averaged by 5-year periods and for total period of 30 years

Plot No.	1895-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	1,377	.....	1,769	.....	1,881	.....	1,578	.....	898	.....	1
					2,542	.....	1,833	.....	1,523	.....	
2	1,970	461	2,048	258	2,753	871	1,799	283	1,094	289	2
					3,349	842	2,217	461	1,818	406	
3	1,735	94	1,905	93	2,210	328	1,585	132	756	46	3
					2,426	—44	1,836	158	1,454	154	
4	1,772	....	1,833	.....	1,883	.....	1,391	.....	616	.....	4
					2,434	.....	1,601	.....	1,189	.....	
5	1,842	101	2,245	483	2,300	478	1,690	290	988	384	5
					2,863	414	2,025	386	1,820	560	
6	2,775	1,066	2,442	753	3,272	1,510	2,290	880	1,714	1,124	6
					3,971	1,506	3,009	1,334	2,366	1,036	
7	1,677	.....	1,617	.....	1,703	.....	1,419	.....	578	.....	7
					2,480	.....	1,712	.....	1,401	.....	
8	2,472	806	1,954	325	3,118	1,391	2,119	783	1,362	809	8
					4,025	1,553	2,768	1,159	2,215	814	
9	2,022	367	1,927	288	2,199	447	1,671	419	876	348	9
					2,854	389	2,075	568	1,775	372	
10	1,645	.....	1,650	.....	1,776	.....	1,168	.....	503	.....	10
					2,457	.....	1,405	.....	1,403	.....	
11	2,740	1,033	2,583	988	3,472	1,715	2,442	1,223	1,828	1,276	11
					4,253	1,900	3,015	1,523	2,635	1,280	
12	2,940	1,172	2,686	1,146	3,469	1,731	2,543	1,272	1,955	1,355	12
					4,320	2,071	3,138	1,559	2,686	1,379	
13	1,830	.....	1,484	.....	1,719	.....	1,323	.....	649	.....	13
					2,143	.....	1,666	.....	1,260	.....	
14	2,815	1,058	2,216	749	2,720	1,045	2,062	767	1,423	796	14
					3,593	1,478	2,565	962	2,042	804	
15	2,277	594	1,957	509	2,421	791	1,972	704	1,181	575	15
					3,008	922	2,425	884	1,807	591	
16	1,610	.....	1,429	.....	1,586	.....	1,239	.....	584	.....	16
					2,058	.....	1,479	.....	1,195	.....	
17	2,590	923	2,176	705	2,926	1,286	2,357	1,072	1,881	1,266	17
					4,557	2,468	3,193	1,663	2,737	1,472	
18	3,130	1,407	2,808	1,294	4,212	2,517	3,445	2,113	2,914	2,270	18
					5,301	3,180	3,969	2,388	3,406	2,071	
19	1,780	.....	1,556	.....	1,750	.....	1,378	.....	674	.....	19
					2,153	.....	1,632	.....	1,404	.....	
20	2,550	863	2,285	787	3,044	1,423	2,340	985	1,650	1,045	20
					3,830	1,739	2,809	1,194	2,347	981	
21	2,517	924	1,955	515	2,755	1,264	2,396	1,066	1,505	970	21
					3,797	1,768	2,818	1,220	2,317	989	
22	1,500	.....	1,382	.....	1,362	.....	1,307	.....	466	.....	22
					1,968	.....	1,581	.....	1,291	.....	
23	2,510	946	1,902	437	2,774	1,301	2,355	977	1,484	959	23
					3,693	1,633	2,923	1,286	2,313	982	
24	2,420	792	1,976	428	2,895	1,311	2,478	1,028	1,392	806	24
					4,204	2,053	2,953	1,261	2,577	1,206	
25	1,692	.....	1,630	.....	1,695	.....	1,521	.....	645	.....	25
					2,243	.....	1,748	.....	1,411	.....	
26	2,645	953	2,618	950	3,981	2,196	2,624	1,155	1,803	1,118	26
					4,875	2,545	3,197	1,477	2,584	1,208	
27	2,352	662	2,285	578	3,230	1,355	2,277	860	1,454	728	27
					4,391	1,974	2,930	1,238	2,293	951	
28	1,690	.....	1,745	.....	1,965	.....	1,365	.....	766	.....	28
					2,504	.....	1,664	.....	1,307	.....	
29	2,535	845	2,532	787	3,676	1,711	2,800	1,435	2,277	1,511	29
					4,150	1,646	3,184	1,520	2,434	1,127	
30	2,470	780	2,303	558	3,819	1,854	2,645	1,280	2,081	1,315	30
					4,384	1,880	3,461	1,797	2,318	1,011	
O	1,657	.....	1,610	.....	1,732	.....	1,369	.....	638	.....	O
					2,298	.....	1,632	.....	1,338	.....	
F	2,465	808	2,247	637	3,063	1,331	2,294	925	1,581	943	F
					3,892	1,594	2,825	1,193	2,297	959	

TABLE 27.—Yield and increase of CLOVER HAY grown in 5-year rotation at Wooster. Pounds per acre
Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919–1923 Yield	1919–1923 Increase	28 crops* Yield	28 crops* Increase	Total fertilizing materials on preceding crop of rotation—pounds per acre†		Plot No.
1	1,069	.....	1,363	.....	None	East.	1
	2,462	.....	.....	.....	None	West.	
2	1,324	300	1,731	377	Acid phosphate, 320	East.	2
	2,603	316	.....	.....	Acid phosphate, 320	West.	
3	1,135	155	1,457	117	Muriate potash, 260	East.	3
	2,194	81	.....	.....	Muriate potash, 260	West.	
4	935	.....	1,329	.....	None	East.	4
	1,938	.....	.....	.....	None	West.	
5	1,305	391	1,643	340	Nitrate soda, 480	East.	5
	2,280	290	.....	.....	Nitrate soda, 480	West.	
6	1,728	836	2,303	1,026	Acid phosphate, 320; nitrate soda, 480	East.	6
	3,050	1,009	.....	.....	Acid phosphate, 320; nitrate soda, 480	West.	
7	870	.....	1,250	.....	None	East.	7
	2,092	.....	.....	.....	None	West.	
8	1,481	650	1,980	749	Acid phosphate, 320; muriate potash, 260	East.	8
	3,096	1,001	.....	.....	Acid phosphate, 320; muriate potash, 260	West.	
9	1,152	362	1,595	384	Muriate potash, 260; nitrate soda, 480	East.	9
	2,662	565	.....	.....	Muriate potash, 260; nitrate soda, 480	West.	
10	751	.....	1,191	.....	None	East.	10
	2,099	.....	.....	.....	None	West.	
11	2,090	1,307	2,473	1,263	Acid phos., 320; muriate potash, 260; nitrate soda, 480	East.	11
	3,371	1,243	.....	.....	Acid phos., 320; muriate potash, 260; nitrate soda, 480	West.	
12	2,270	1,456	2,582	1,354	Acid phos., 320; muriate potash, 260; nitrate soda, 720	East.	12
	3,671	1,513	.....	.....	Acid phos., 320; muriate potash, 260; nitrate soda, 720	West.	
13	846	.....	1,246	.....	None	East.	13
	2,187	.....	.....	.....	None	West.	
14	1,575	707	2,073	853	Acid phos., 240; muriate potash, 180; nitrate soda, 320	East.	14
	2,852	732	.....	.....	Acid phos., 240; muriate potash, 180; nitrate soda, 320	West.	
15	1,462	572	1,796	601	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East.	15
	2,500	447	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West.	
16	912	.....	1,169	.....	None	East.	16
	1,986	.....	.....	.....	None	West.	
17	1,984	1,099	2,290	1,100	Acid phos., 480; muriate potash, 260; nitrate soda, 240	East.	17
	3,680	1,621	.....	.....	Acid phos., 480; muriate potash, 260; nitrate soda, 240	West.	
18	3,469	2,612	3,278	2,068	Yard manure, 16 tons	East.	18
	4,387	2,255	.....	.....	Yard manure, 16 tons	West.	
19	829	.....	1,230	.....	None	East.	19
	2,205	.....	.....	.....	None	West.	
20	2,147	1,341	2,285	1,100	Yard manure, 8 tons	East.	20
	3,391	1,240	.....	.....	Yard manure, 8 tons	West.	
21	1,761	977	2,045	905	Fertilized as 17, but nitrogen in oilmeal	East.	21
	3,446	1,350	.....	.....	Fertilized as 17, but nitrogen in oilmeal	West.	
22	761	.....	1,094	.....	None	East.	22
	2,042	.....	.....	.....	None	West.	
23	1,714	917	1,976	816	Fertilized as 17, but nitrogen in dried blood	East.	23
	3,435	1,318	.....	.....	Fertilized as 17, but nitrogen in dried blood	West.	
24	1,424	591	1,958	735	Fertilized as 17, but nitrogen in sulphate ammonia	East.	24
	3,584	1,392	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West.	
25	869	.....	1,286	.....	None	East.	25
	2,268	.....	.....	.....	None	West.	
26	2,009	1,070	2,577	1,257	Fertilized as 11, but phosphorus in bonemeal	East.	26
	3,537	1,244	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West.	
27	1,869	860	2,227	875	Fertilized as 17, but nitrogen in nitrate of lime	East.	27
	3,687	1,369	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West.	
28	1,079	.....	1,385	.....	None	East.	28
	2,342	.....	.....	.....	None	West.	
29	2,770	1,691	2,758	1,073	Fertilized as 11, but phosphorus in basic slag	East.	29
	3,446	1,104	.....	.....	Fertilized as 11, but phosphorus in basic slag	West.	
30	2,398	1,319	2,586	1,201	Fertilized as 17, but nitrogen in tankage	East.	30
	3,404	1,062	.....	.....	Fertilized as 17, but nitrogen in tankage	West.	
O	892	.....	1,255	.....	Average unfertilized yields	East.	O
	2,162	.....	.....	.....	Average unfertilized yields	West.	
F	1,864	972	2,182	927	Average fertilized yields	East.	F
	3,214	1,052	.....	.....	Average fertilized yields	West.	

*Crop failed in 1902.
†See note page 299.

TABLE 28.—Yield and increase of TIMOTHY HAY grown in 5-year rotation at Wooster. Pounds per acre. Averaged by 5-year periods and for total period of 30 years

Plot No.	1896-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
1	2,553	.....	2,498	.....	3,103	.....	2,853	.....	2,034	.....	1
					3,672	.....	2,742	.....	2,869	.....	
2	2,597	38	2,688	193	3,319	331	2,884	144	2,254	333	2
					4,201	620	3,431	676	3,556	708	
3	3,013	449	2,540	48	2,902	30	2,514	—113	1,876	69	3
					3,562	74	2,991	222	3,051	223	
4	2,570	.....	2,489	.....	2,757	.....	2,515	.....	1,694	.....	4
					3,397	.....	2,781	.....	2,808	.....	
5	2,783	260	2,778	350	3,460	739	2,773	314	1,981	326	5
					3,962	621	3,044	215	2,964	129	
6	3,083	607	2,894	528	3,885	1,198	3,213	811	2,614	998	6
					4,504	1,220	3,680	803	3,672	810	
7	2,430	.....	2,308	.....	2,652	.....	2,346	.....	1,576	.....	7
					3,228	.....	2,924	.....	2,890	.....	
8	2,743	350	2,577	294	3,328	677	2,768	452	2,358	852	8
					4,070	860	3,635	700	3,573	786	
9	2,637	280	2,483	224	3,260	611	2,640	353	1,681	244	9
					3,853	662	3,386	441	2,801	117	
10	2,320	.....	2,234	.....	2,647	.....	2,258	.....	1,367	.....	10
					3,174	.....	2,955	.....	2,581	.....	
11	2,943	613	3,127	844	4,103	1,446	3,089	794	2,435	1,022	11
					4,736	1,597	3,840	942	3,582	988	
12	2,567	227	3,135	802	4,088	1,422	3,080	748	2,533	1,074	12
					4,625	1,521	4,013	1,173	3,575	971	
13	2,350	.....	2,382	.....	2,673	.....	2,369	.....	1,505	.....	13
					3,068	.....	2,782	.....	2,620	.....	
14	2,813	456	2,954	634	3,340	750	2,724	390	2,047	507	14
					4,069	1,006	3,231	464	3,094	447	
15	2,490	124	2,732	474	3,052	546	2,671	371	1,923	349	15
					3,628	571	3,009	259	3,022	347	
16	2,373	.....	2,196	.....	2,424	.....	2,267	.....	1,608	.....	16
					3,052	.....	2,733	.....	2,702	.....	
17	2,800	404	2,552	323	3,444	997	3,058	757	2,570	891	17
					4,657	1,496	4,058	1,213	4,529	1,766	
18	3,633	1,216	3,088	826	4,626	2,156	4,142	1,807	3,700	1,949	18
					5,707	2,438	5,018	2,063	5,034	2,212	
19	2,440	.....	2,294	.....	2,493	.....	2,369	.....	1,821	.....	19
					3,377	.....	3,066	.....	2,882	.....	
20	3,370	1,009	2,730	549	3,696	1,223	3,271	957	2,467	737	20
					4,714	1,463	4,124	1,151	3,719	944	
21	2,717	428	2,568	501	3,185	729	2,955	686	2,253	613	21
					4,280	1,157	3,946	1,067	3,379	712	
22	2,213	.....	1,953	.....	2,437	.. ....	2,204	.....	1,549	.....	22
					2,995	.....	2,786	.....	2,558	.....	
23	2,783	431	2,465	430	3,199	682	2,831	496	2,282	682	23
					4,247	1,132	3,973	1,048	3,476	815	
24	2,727	235	2,494	377	3,018	422	2,916	451	2,419	769	24
					4,408	1,175	4,142	1,077	3,923	1,160	
25	2,630	.....	2,198	.....	2,677	.....	2,594	.....	1,699	.....	25
					3,352	.....	3,204	.....	2,865	.....	
26	3,367	550	2,916	689	3,993	1,246	3,049	498	2,428	668	26
					5,046	1,636	4,253	1,074	3,991	1,195	
27	3,320	317	2,801	545	3,677	859	2,826	320	2,304	482	27
					4,673	1,205	4,071	917	3,644	919	
28	3,190	.....	2,284	.....	2,889	.....	2,462	.....	1,883	.....	28
					3,525	.....	3,129	.....	2,656	.....	
29	3,790	600	3,196	912	4,136	1,247	3,537	1,075	2,590	707	29
					4,665	1,140	4,151	1,022	3,302	646	
30	3,797	607	3,008	724	4,097	1,208	3,324	862	3,008	1,125	30
	.....	.....	.....	.....	4,798	1,273	4,173	1,044	3,732	1,076	
O	2,507	.....	2,284	.....	2,675	.....	2,424	.....	1,689	.....	O
					3,284	.....	2,910	.....	2,743	.....	
F	2,999	492	2,786	502	3,590	915	3,013	589	2,386	697	F
	.....	.....	....	.....	4,420	1,136	3,808	898	3,581	838	

TABLE 28.—Yield and increase of TIMOTHY HAY grown in 5-year rotation at Wooster. Pounds per acre. Averaged by 5-year periods and for total period of 30 years—Continued

Plot No.	1919–1923 Yield	1919–1923 Increase	26 crops* Yield	26 crops* Increase	Total fertilizing materials on preceding crops of rotation—pounds per acre		Plot No.
1	2,076	.....	2,523	.....	None	East..	1
	3,104	.....	.....	.....	None	West..	
2	2,226	280	2,673	232	Acid phosphate, 320	East..	2
	3,591	526	.....	.....	Acid phosphate, 320	West..	
3	1,910	94	2,437	78	Muriate potash, 260	East..	3
	3,438	412	.....	.....	Muriate potash, 260	West..	
4	1,685	.....	2,277	.....	None	East..	4
	2,987	.....	.....	.....	None	West..	
5	1,927	248	2,623	385	Nitrate soda, 480	East..	5
	2,915	—75	.....	.....	Nitrate soda, 480	West..	
6	2,247	573	2,988	790	Acid phosphate, 320; nitrate soda, 480	East..	6
	3,651	658	.....	.....	Acid phosphate, 320; nitrate soda, 480	West..	
7	1,668	.....	2,158	.....	None	East..	7
	2,997	.....	.....	.....	None	West..	
8	2,453	729	2,713	568	Acid phosphate, 320; muriate potash, 260	East..	8
	3,979	975	.....	.....	Acid phosphate, 320; muriate potash, 260	West..	
9	2,073	291	2,472	341	Muriate potash, 260; nitrate soda, 480	East..	9
	3,275	266	.....	.....	Muriate potash, 260; nitrate soda, 480	West..	
10	1,838	.....	2,118	.....	None	East..	10
	3,015	.....	.....	.....	None	West..	
11	3,022	1,156	3,161	1,013	Acid phos., 320; muriate potash, 260; nitrate soda, 480	East..	11
	3,865	849	.....	.....	Acid phos., 320; muriate potash, 260; nitrate soda, 480	West..	
12	2,716	824	3,071	893	Acid phos., 320; muriate potash, 260; nitrate soda, 720	East..	12
	3,844	826	.....	.....	Acid phos., 320; muriate potash, 260; nitrate soda, 720	West..	
13	1,920	.....	2,208	.....	None	East..	13
	3,018	.....	.....	.....	None	West..	
14	2,283	447	2,708	543	Acid phos., 240; muriate potash, 180; nitrate soda, 320	East..	14
	3,339	400	.....	.....	Acid phos., 240; muriate potash, 180; nitrate soda, 320	West..	
15	2,116	364	2,513	391	Acid phos., 160; muriate potash, 100; nitrate soda, 160	East..	15
	3,154	294	.....	.....	Acid phos., 160; muriate potash, 100; nitrate soda, 160	West..	
16	1,668	.....	2,079	.....	None	East..	16
	2,780	.....	.....	.....	None	West..	
17	2,962	1,185	2,911	782	Acid phos., 480; muriate potash, 260; nitrate soda, 240	East..	17
	4,135	1,309	.....	.....	Acid phos., 480; muriate potash, 260; nitrate soda, 240	West..	
18	4,082	2,196	3,894	1,714	Yard manure, 16 tons	East..	18
	5,341	2,468	.....	.....	Yard manure, 16 tons	West..	
19	1,995	.....	2,230	.....	None	East..	19
	2,919	.....	.....	.....	None	West..	
20	3,001	1,104	3,085	930	Yard manure, 8 tons	East..	20
	4,263	1,404	.....	.....	Yard manure, 8 tons	West..	
21	2,624	826	2,726	646	Fertilized as 17, but nitrogen in oilmeal	East..	21
	4,029	1,230	.....	.....	Fertilized as 17, but nitrogen in oilmeal	West..	
22	1,700	.....	2,004	.....	None	East..	22
	2,737	.....	.....	.....	None	West..	
23	2,546	831	2,687	605	Fertilized as 17, but nitrogen in dried blood	East..	23
	3,918	1,065	.....	.....	Fertilized as 17, but nitrogen in dried blood	West..	
24	2,585	854	2,692	533	Fertilized as 17, but nitrogen in sulphate ammonia	East..	24
	4,085	1,118	.....	.....	Fertilized as 17, but nitrogen in sulphate ammonia	West..	
25	1,746	.....	2,237	.....	None	East..	25
	3,082	.....	.....	.....	None	West..	
26	2,485	670	3,038	744	Fertilized as 11, but phosphorus in bonemeal	East..	26
	3,925	865	.....	.....	Fertilized as 11, but phosphorus in bonemeal	West..	
27	2,603	717	2,919	568	Fertilized as 17, but nitrogen in nitrate of lime	East..	27
	4,195	1,158	.....	.....	Fertilized as 17, but nitrogen in nitrate of lime	West..	
28	1,955	.....	2,407	.....	None	East..	28
	3,015	.....	.....	.....	None	West..	
29	3,264	1,309	3,418	1,010	Fertilized as 11, but phosphorus in basic slag	East..	29
	3,922	907	.....	.....	Fertilized as 11, but phosphorus in basic slag	West..	
30	3,559	1,604	3,463	1,056	Fertilized as 17, but nitrogen in tankage	East..	30
	3,932	917	.....	.....	Fertilized as 17, but nitrogen in tankage	West..	
O	1,825	.....	1,825	.....	Average unfertilized yield	East..	O
	2,965	.....	.....	.....	Average unfertilized yield	West..	
F	2,634	809	2,689	864	Average fertilized yield	East..	F
	3,840	875	.....	.....	Average fertilized yield	West..	

*Crop failed in 1909 and 1915.

TABLE 29.—Annual value of increase from treatment and net value over cost of fertilizers and limestone in 5-year rotation at Wooster

Plot No.	1894-1898		1899-1903		1904-1908		1909-1913		1914-1918		Plot No.
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	
2	$2.61	$1.97	$5.45	$4.81	$7.02	$6.38	$4.28	$3.64	$5.61	$4.97	2
					10.84	8.20	8.15	5.51	10.86	8.22	
3	1.84	0.54	1.69	0.39	2.67	1.37	0.73	—0.57	1.93	0.63	3
					5.54	2.24	3.97	0.67	8.39	5.09	
5	1.58	—1.78	3.32	—0.04	4.03	0.67	2.84	—0.52	3.40	0.04	5
					7.33	1.97	4.88	—0.48	9.25	5.89	
6	6.59	2.59	10.53	6.53	12.59	8.59	10.12	6.12	12.33	8.33	6
					15.94	9.94	13.54	7.54	16.30	10.30	
8	4.85	2.91	7.25	5.31	9.87	7.93	8.62	6.68	9.69	7.75	8
					14.52	10.58	12.41	8.47	16.88	12.94	
9	2.05	—2.61	3.23	—1.43	4.54	—0.12	4.46	—0.20	3.89	—0.77	9
					8.24	1.58	8.14	1.48	11.57	4.91	
11	8.28	2.98	12.94	7.64	15.88	10.58	12.67	7.37	14.73	9.43	11
					18.81	11.51	16.11	8.81	20.62	13.32	
12	8.10	1.12	13.95	6.97	15.73	8.75	12.55	5.57	15.32	8.34	12
					19.00	10.02	17.12	8.14	20.44	11.46	
14	6.90	3.28	10.20	6.58	11.55	7.93	9.37	5.75	11.46	7.84	14
					15.01	9.49	11.46	5.84	15.94	10.32	
15	4.09	2.15	7.01	5.07	8.16	6.22	6.26	4.32	7.94	6.00	15
					11.43	7.49	9.36	5.42	13.09	9.15	
17	5.34	1.40	10.86	6.92	13.66	9.72	12.83	8.89	13.89	9.95	17
					19.45	13.51	17.19	11.25	21.33	15.39	
18	7.51	4.31	10.41	7.21	17.20	14.00	17.63	14.43	17.80	14.60	18
					22.20	17.00	21.41	16.21	23.17	19.97	
20	5.15	3.55	6.63	5.03	10.62	9.02	9.71	8.11	9.49	7.89	20
					15.26	11.66	14.14	10.54	15.06	11.46	
21	6.67	2.73	10.95	7.01	12.19	8.25	11.72	7.78	11.78	7.84	21
					17.95	12.01	16.06	10.12	17.98	12.04	
23	6.27	2.33	10.36	6.42	11.63	7.69	11.01	7.07	11.54	7.60	23
					17.07	11.13	15.86	9.92	18.73	12.79	
24	6.59	2.65	9.89	5.95	11.14	7.20	10.38	6.44	11.52	7.58	24
					17.92	11.98	16.60	10.66	19.68	13.74	
26	6.63	1.33	10.75	5.45	13.57	8.27	9.76	4.46	12.33	7.03	26
					18.04	10.74	13.74	6.44	16.73	9.43	
27	6.03	.73	11.92	6.62	13.02	7.72	10.10	4.80	11.10	5.80	27
					17.39	10.09	14.65	7.35	16.64	9.34	
29	6.88	1.58	11.88	6.58	13.89	8.59	11.99	6.69	13.42	8.12	29
					15.31	8.01	13.59	6.29	16.27	8.97	
30	4.60	0.66	9.12	5.28	13.94	10.00	12.35	8.41	12.85	8.91	30
					15.92	9.98	14.85	8.91	16.12	10.18	
	5.43	.....	8.92	.....	11.14	.....	9.47	.....	10.60	.....	
	.....	.....	.....	.....	15.16	.....	13.16	.....	16.25	.....	
	.....	.....	.....	.....	4.02	.....	3.69	.....	5.65	.....	

TABLE 29.—Annual value of increase from treatment and net value over cost of fertilizers and limestone in 5-year rotation at Wooster—Continued

Plot No.	1919–1923		20 years 1904–1923		Treatment Pounds per acre for each 5-year rotation					Plot No.
	Total	Net	Total	Net	Acid phosphate	Muriate potash	Nitrate soda	Ground limestone	Annual cost	
2	$ 4.49	$ 3.85	$ 5.28	$ 4.64	330	.....	.....	.....	$0.64	2
	12.20	9.56	10.51	7.87	320	.....	.....	2 tons	2.64	
3	1.83	0.53	1.79	0.49	.....	260	.....	.....	1.30	3
	12.27	8.97	7.54	4.24	.....	260	.....	2 tons	3.30	
5	2.72	—0.64	3.24	—0.12	.....	.....	480	.....	3.36	5
	10.33	4.97	7.95	2.59	.....	.....	480	2 tons	5.36	
6	9.60	5.60	11.16	7.16	320	.....	480	.....	4.00	6
	15.86	9.86	15.41	9.41	320	.....	480	2 tons	6.00	
8	8.53	6.59	9.18	7.24	320	260	.....	.....	1.94	8
	19.10	15.16	15.73	11.79	320	260	.....	2 tons	3.94	
9	3.57	—1.09	4.11	—0.55	.....	260	480	.....	4.66	9
	14.28	7.62	10.56	3.90	.....	260	480	2 tons	6.66	
11	14.00	8.70	14.32	9.02	320	260	480	.....	5.30	11
	21.92	14.62	19.36	12.06	320	260	480	2 tons	7.30	
12	15.30	8.32	14.72	7.74	320	260	720	.....	6.98	12
	22.63	13.65	19.80	10.82	320	260	720	2 tons	8.98	
14	10.14	6.52	10.63	7.01	240	180	320	.....	3.62	14
	17.33	11.71	14.93	9.31	240	180	320	2 tons	5.62	
15	7.15	5.21	7.38	5.44	160	100	160	.....	1.94	15
	13.86	9.92	11.93	7.99	160	100	160	2 tons	3.94	
17	14.92	10.98	13.85	9.91	480	260	240	.....	3.94	17
	22.15	18.21	20.03	14.09	480	260	240	2 tons	5.94	
18	19.12	15.92	17.94	14.74	Barnyard manure, 16 tons			.....	3.20	18
	24.88	19.68	22.91	17.71	Barnyard manure, 16 tons			2 tons	5.20	
20	10.64	9.04	10.12	8.52	Barnyard manure, 8 tons			.....	1.60	20
	18.49	14.89	15.74	12.14	Barnyard manure, 8 tons			2 tons	3.60	
21	12.78	8.84	12.12	8.18	As 17, nitrogen in oilmeal			.....	3.94	21
	21.26	15.32	18.31	12.37	As 17, nitrogen in oilmeal			2 tons	5.94	
23	12.14	8.20	11.58	7.64	As 17, nitrogen in dried blood			.....	3.94	23
	21.53	15.59	18.30	12.36	As 17, nitrogen in dried blood			2 tons	5.94	
24	11.17	7.23	11.05	7.11	As 17, nit. in sulph. ammonia			.....	3.94	24
	22.21	16.27	19.10	13.16	As 17, nit. in sulph. ammonia			2 tons	5.94	
26	11.61	6.31	11.82	6.52	As 11, phosphorus in bonemeal			.....	5.30	26
	18.78	11.48	16.82	9.52	As 11, phosphorus in bonemeal			2 tons	7.30	
27	12.16	6.86	11.59	7.65	As 11 to 1910; as 17 since			.....	3.94	27
	21.07	13.77	17.44	11.50	As 11 to 1910; as 17 since			2 tons	5.94	
29	16.12	10.82	13.86	8.56	As 11, phosphorus in basic slag			.....	5.30	29
	19.98	12.68	16.30	9.00	As 11, phosphorus in basic slag			2 tons	7.30	
30	13.43	9.49	13.14	9.20	As 17, nitrogen in tankage			.....	3.94	30
	18.03	12.09	16.23	10.29	As 17, nitrogen in tankage			2 tons	5.94	
	10.57	.....	10.44	.....	Average value of gain from fertilizers alone					
	18.41	.....	15.74	.....	Average value of gain from fertilizers and limestone					
	7.84	.....	5.30	.....	Average gain for liming					

TABLE 30—LIME AND FLOATS TEST—Crops grown in 3-year rotation at Wooster

Plot No.	Treatment (Lime, manure, etc., per acre applied to corn only)	Corn—19 years				Oats—19 years				Clover—18 years		Value of increase per rotation	Cost of treatment per rotation	Balance	Plot No.
		Grain		Stover		Grain		Straw		Hay					
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase				
		Bu.	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	
1	None	43.57	.....	2,237	.....	42.67	.....	1,818	.....	3,200	.....	.....	.....	.....	1
2	Quicklime, 500 lb.; manure, 8 tons	65.19	21.54	2,956	714	53.08	9.86	2,169	397	4,606	1,387	32.20	11.00	21.20	2
3	Quicklime, 1,000 lb.; manure, 8 tons	66.52	22.80	3,029	782	53.31	9.54	2,153	426	4,806	1,333	34.55	14.00	20.55	3
4	None	43.79	.....	2,251	.....	44.31	.....	1,681	.....	3,260	.....	.....	.....	.....	4
5	Quicklime, 2,000 lb.; manure, 8 tons	70.27	25.84	3,231	954	54.68	10.37	2,286	608	5,288	2,045	41.48	20.00	21.48	5
6	Ground limestone, 1,780 lb.; manure, 8 tons	69.24	24.16	3,094	792	53.44	9.16	2,105	431	4,830	1,605	35.67	12.45	23.22	6
7	None	45.73	.....	2,328	.....	44.27	.....	1,671	.....	3,207	.....	.....	.....	.....	7
8	Air-slaked lime, 1,780 lb.; manure, 8 tons	70.68	25.72	3,250	959	55.38	12.25	2,221	595	5,133	2,036	42.06	16.90	25.16	8
9	Hydrated lime, 1,320 lb.; manure, 8 tons	67.82	23.62	3,118	864	54.63	12.62	2,169	589	4,790	1,804	38.74	14.60	24.14	9
10	None	43.42	.....	2,218	.....	40.88	.....	1,534	.....	2,876	.....	.....	.....	.....	10
11	Gypsum, 1,000 lb.; manure, 8 tons	60.64	17.93	2,798	611	51.08	10.23	1,952	443	3,582	763	25.00	13.00	12.00	11
12	Floats, 1,000 lb.; manure, 8 tons	62.27	20.28	2,819	666	54.31	13.50	2,088	610	3,845	1,083	30.90	15.50	15.40	12
13	None	41.27	.....	2,122	.....	40.78	.....	1,450	.....	2,705	.....	.....	.....	.....	13
14	Quicklime, 1,000 lb	49.06	8.23	2,529	408	47.40	6.51	1,705	261	3,970	1,283	19.60	6.00	13.60	14
15	Ground limestone, 1,780 lb	47.04	5.94	2,311	190	45.11	4.12	1,601	166	3,723	1,054	14.60	4.45	10.15	15
16	None	39.91	.....	2,121	.....	41.09	.....	1,435	.....	2,650	.....	.....	.....	.....	16
17	Quicklime, 1,000 lb.; acid phosphate, 320 lb.; muriate potash, 40 lb.	62.04	21.59	2,931	806	53.24	12.03	1,933	462	4,485	1,816	36.71	10.20	26.51	17
18	Quicklime, 1,000 lb.; floats, 320 lb.; muriate potash, 40 lb;	57.65	16.65	2,792	663	49.99	8.65	1,783	275	4,243	1,555	29.12	9.40	19.72	18
19	None	41.53	.....	2,133	.....	41.46	.....	1,543	.....	2,707	.....	.....	.....	.....	19
20	Acid phosphate, 320 lb	49.16	8.13	2,377	278	44.99	4.08	1,609	105	2,877	192	9.72	3.20	6.52	20
21	Acid phos., 320 lb.; muriate potash, 40 lb.	54.68	14.16	2,606	541	45.88	5.54	1,689	225	2,981	318	16.35	4.20	12.15	21
22	None	40.02	.....	2,031	.....	39.79	.....	1,425	.....	2,640	.....	.....	.....	.....	22
23	Floats, 320 lb	44.51	5.56	2,191	186	42.13	3.29	1,510	119	2,731	181	7.33	2.40	4.93	23
24	Floats, 320 lb.; muriate potash, 40 lb.	48.13	10.24	2,393	413	42.11	4.21	1,475	119	2,675	215	11.79	3.40	8.39	24
25	None	36.82	.....	1,954	.....	36.95	.....	1,320	.....	2,369	.....	.....	.....	.....	25
26	Manure, 8 tons since 1909*	52.64	19.84	3,201	687	44.66	7.71	1,604	284	3,304	934	26.40	8.00	18.40	26
	Average unfertilized yield	41.78	.....	2,155	.....	41.35	.....	1,542	.....	2,852	.....	.....	.....	.....	

*Previously, floats, 320 lb.; muriate of potash, 40 lb.; dried blood, 100 lb.

Notice: The lime or gypsum or floats and manure are not mixed together. The manure is plowed under and the lime or other materials applied to the surface.

TABLE 31.—SUPPLEMENTAL LIME TESTS AT WOOSTER—Place in rotation, quantity, fineness of grinding, and limestone vs. hydrated lime

Plot No.	Kind and condition of limestone or lime, and amount per acre*	Corn—9 crops		Oats—9 crops		Wheat—9 crops		Clover hay—8 crops	Plot No.
		Grain	Stover	Grain	Straw	Grain	Straw		
	Part I: Average yield per acre, 1915-1923, and total value of crops for each rotation of 4 years								
		Bu.	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	
1	None	52.26	2,357	49.20	2,539	27.11	2,713	3,266	1
2	Limestone, fine, 2 tons on corn	63.16	2,788	52.12	2,574	29.43	3,003	4,302	2
3	Limestone, fine, 2 tons on wheat	61.86	2,722	51.53	2,496	30.26	3,051	4,404	3
4	None	53.80	2,339	51.94	2,251	27.11	2,700	2,993	4
5	Limestone, fine, 2 tons on clover, new seeding in fall	59.22	2,590	51.75	2,365	28.72	2,843	3,783	5
6	Limestone, fine, 2 tons on clover sod, before plowing	60.18	2,567	52.00	2,376	29.05	2,764	3,569	6
7	None	49.33	2,160	48.82	2,394	24.42	2,315	2,607	7
8	Limestone, fine, ½ ton each crop	56.42	2,468	51.43	2,286	26.74	2,398	3,560	8
9	Limestone, coarse, 2 tons on corn	57.68	2,391	50.88	2,341	27.06	2,532	3,341	9
10	None	50.25	2,179	50.47	2,412	25.03	2,351	2,696	10
11	Limestone, coarse, 4 tons on corn	60.00	2,616	53.07	2,438	29.68	2,864	3,582	11
12	Limestone, fine, 4 tons on corn	62.50	2,634	53.63	2,554	29.43	2,881	3,894	12
13	None	50.56	2,203	49.58	2,393	25.30	2,306	2,688	13
14	Limestone, magnesian, fine, 2 tons on corn	61.34	2,668	52.29	2,393	28.77	2,751	3,778	14
15	Lime, magnesian, hydrated, 1½ tons on corn	62.54	2,728	53.56	2,605	29.87	2,941	3,970	15
16	None	51.32	2,305	51.94	2,346	26.53	2,583	2,921	16
17	Limestone, non-magnesian, fine, 2 tons on corn	61.39	2,536	53.99	3,704	30.50	3,064	3,813	17
18	Lime, non-magnesian, hydrated, 1½ tons on corn	62.94	2,671	54 82	2,763	30.70	3,032	3,807	18
19	None	51.13	2,277	50.94	2,647	26.28	2,543	2,867	19
20	Limestone, fine, 8 tons on corn	61.12	2,603	54.95	2,862	31.15	3,153	4,493	20
	Average unlimed plots	51.24	2,260	50.41	2,426	25.93	2,490	2,863	

*All plots receive 8 tons of manure per acre on corn and 320 pounds of acid phosphate on wheat.

TABLE 31.—SUPPLEMENTAL LIME TESTS AT WOOSTER—Place in rotation, quantity, fineness of grinding, and limestone vs. hydrated lime—Continued

Plot No.	Kind and condition of limestone or lime, and amount per acre	Corn—9 crops		Oats—9 crops		Wheat—9 crops		Clover hay—8 crops	Value	Plot No.
		Grain	Stover	Grain	Straw	Grain	Straw			
	Part II: Average increase per acre and total value of increase for entire rotation of 4 years									
		Bu.	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Dol.*	
2	Limestone, fine, 2 tons on corn	10.39	437	2.00	131	2.32	294	1,127	21.00	2
3	Limestone, fine, 2 tons on wheat	8.57	377	.50	149	3.14	347	1,320	21.42	3
5	Limestone, fine, 2 tons on clover, new seeding	6.91	311	.85	66	2.51	271	918	16.19	5
6	Limestone, fine, 2 tons on clover sod	9.36	348	2.14	29	3.73	320	833	19.13	6
8	Limestone, fine, ½ ton on each crop	6.78	302	2.06	—114	2.12	71	923	15.26	8
9	Limestone, coarse, 2 tons on corn	7.73	219	.97	—65	2.24	193	675	13.97	9
11	Limestone, coarse, 4 tons on corn	9.64	429	2.90	33	4.56	528	889	21.61	11
12	Limestone, fine, 4 tons on corn	12.04	439	3.75	154	4.22	560	1,203	26.09	12
14	Limestone, fine, 2 tons on corn (magnesian)	10.53	431	1.92	16	3.07	353	1,012	20.80	14
15	Lime, hydrated, 1½ tons on corn (magnesian)	11.47	457	2.40	244	3.74	451	1,121	24.02	15
17	Limestone fine, 2 tons on corn (non-magnesian)	10.13	240	2.39	259	4.04	494	909	21.39	17
18	Lime, hydrated, 1½ tons on corn (non-magnesian)	11.74	384	3.55	217	4.33	475	921	23.56	18
20	Limestone, fine, 8 tons on corn	9.99	326	4.01	215	4.87	610	1,626	28.54	20

TABLE 32.—Supplemental fertility tests at Wooster—Fertilizing materials per acre for one rotation, essential constituents, and crops fertilized

Plot No.	Fertilizing materials for one rotation			Essential constituents			Crops fertilized				Plot No.
	Nitrate of soda	Acid phosphate	Muriate of potash	Ammonia	Phosphoric acid	Potash	Corn	Oats	Wheat	Clover	
	Pounds per acre										
1											1
2		1,000			160		250	250	250	250	9
3		750	80		120	40	207	207	207	207	3
4											4
5	108	500	40	20	80	20	162	162	162	162	5
6	108	500	40	20	80	20	215	215	215		6
7											7
8	108	500	40	20	80	20	324		324		8
9	108	500	40	20	80	20	648				9
10											10
11	108	500	40	20	80	20			648		11
12	108	500	40	20	80	20				648	12
13											13
14	108	750	40	20	120	20	449		449		14
15	216	750	40	40	120	20	503		503		15
16											16
17	216	500	80	40	80	40	398		398		17
18	216	500	160	40	80	80	438		438		18
19											19
20	216	a	80	40	80	40	*		*		20
21	216	b	80	40	120	40	*		*		21
22											22
23	216	500	c	40	80	40	*		*		23
24	d	500	80	40	80	40	*		*		24
25											25
26	245	112	58	44	18	29	415				26
27	245	592	58	44	94	29	895				27
28											28
29	e			44	18	29	e				29
30	e	480		44	94	29	e				30
31											31
32	f	480		88	112	58	e		e		32
33	f	480		88	112	58	f				33
34											34
35	f	480		88	112	58			f		35
36	f	480		88	112	58				f	35
37											37
38	f	768		88	250	58	f				38
39	f	480	g	88	112	78	f				39
40											40

a Calcined or "duplex basic" phosphate equivalent to 500 lb. acid phosphate.*
b Calcined or "duplex basic" phosphate equivalent to 750 lb. acid phosphate.*
c Feldspar potash equivalent to 80 lb. muriate of potash.*
d Calcium cyanamid equivalent to 216 lb. nitrate of soda.*
e 4 tons shed manure.†
f 8 tons shed manure.†
g 160 lb. kainit.
*a, b, c, and d are divided equally between corn and wheat.
†Manure is plowed under for corn and spread as a topdressing for wheat. The acid phosphate is spread on manured sod for corn and drilled with the wheat. Plots 30 and 33 receive manure and phosphate only on corn; Plot 35 only on wheat; and Plot 36 only on the new seeding of clover after the wheat is harvested.

TABLE 33.—Supplemental fertility tests at Wooster—Annual yield and increase per acre, value of increase, cost of treatment, and balance

Plot No.	Average annual yield per acre							Average annual increase per acre							Annual—			Plot No.
	Corn—9 crops		Oats—8 crops		Wheat—9 crops		Clover	Corn		Oats		Wheat		Clover	Value of increase	Cost of treatment	Balance	
	Grain	Stover	Grain	Straw	Grain	Straw	8 crops	Grain	Stover	Grain	Straw	Grain	Straw					
	Bu.	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	
1	53.15	2,299	49.74	2,394	27.38	3,017	4,311											1
2	63.53	2,699	53.02	2,607	33.85	3,300	4,872	9.61	373	3.53	288	7.59	460	693	5.93	2.80	3.13	2
3	65.98	2,787	56.86	2,644	33.37	3,163	5,017	11.30	435	7.66	400	8.23	501	970	7.45	2.60	4.85	3
4	55.44	2,378	48.94	2,169	24.02	2,484	3,915											4
5	63.20	2,615	54.85	2,462	32.48	3,411	4,747	8.46	271	5.25	312	9.08	962	869	6.87	2.60	4.27	5
6	64.65	2,565	56.49	2,685	34.64	3,331	4,402	10.63	254	6.22	555	11.88	916	562	7.58	2.60	4.98	6
7	53.31	2,279	50.94	2,111	22.14	2,380	3,802											7
8	65.00	2,660	54.91	2,487	35.01	3,606	4,450	11.37	389	3.69	313	12.45	1,188	600	7.78	2.60	5.18	8
9	67.23	2,735	57.87	2,712	28.72	2,808	4,192	13.28	472	6.36	474	6.71	511	294	6.10	2.60	3.50	9
10	54.27	2,255	51.79	2,301	23.39	2,495	3,946											10
11	56.79	2,421	50.51	2,328	37.58	3,855	4,845	8.29	301	1.81	189	14.57	1,457	1,022	8.37	2.60	5.77	11
12	59.15	2,437	49.20	2,113	26.50	2,711	5,168	10.50	371	1.69	39	5.32	465	1,466	6.63	2.60	4.03	12
13	49.36	2,069	48.81	2,056	22.24	2,202	3,580											13
14	63.79	2,645	55.42	2,389	36.75	3,608	4,506	13.60	490	6.16	283	14.20	1,366	974	9.71	3.30	6.41	14
15	64.70	2,626	55.19	2,475	37.20	3,622	4,526	13.56	383	5.48	320	14.35	1,340	1,041	9.74	4.25	5.49	15
16	51.87	2,329	50.16	2,205	23.16	2,322	3,438											16
17	65.09	2,648	55.91	2,428	36.52	3,650	4,344	13.83	393	5.32	226	13.35	1,338	911	9.22	3.80	5.42	17
18	65.91	2,667	55.89	2,402	37.19	3,777	4,347	15.25	486	4.86	204	14.01	1,478	918	9.73	4.30	5.43	18
19	50.06	2,107	51.46	2,196	23.19	2,288	3,425											19
20	62.25	2,561	56.52	2,460	35.99	3,765	4,202	11.23	408	4.98	231	12.41	1,405	674	8.11	3.80	4.31	20

TABLE 33.—Supplemental fertility tests at Wooster—Annual yield and increase per acre, value of increase, cost of treatment, and balance—Continued

Plot No.	Average annual yield per acre							Average annual increase per acre							Annual—			Plot No.
	Corn—9 crops		Oats—8 crops		Wheat—9 crops		Clover 8 crops	Corn		Oats		Wheat		Clover	Value of increase	Cost of treatment	Balance	
	Grain	Stover	Grain	Straw	Grain	Straw		Grain	Straw	Grain	Straw	Grain	Straw					
	Bu.	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	
21	63.72	2,602	59.21	2,666	38.04	3,900	4,585	11.75	403	7.60	404	14.05	1,468	954	9.54	4.50	5.04	21
22	52.93	2,245	51.70	2,294	24.40	2,504	3,734											22
23	63.72	2,619	56.98	2,513	36.28	3,675	4,397	9.88	367	5.11	230	12.39	1,208	625	7.64	3.80	3.84	23
24	66.65	2,755	56.02	2,521	35.31	3,426	4,471	11.91	497	3.97	250	11.92	996	662	7.79	3.80	3.99	24
25	55.66	2,265	52.23	2,258	22.89	2,392	3,845											25
26	61.99	2,505	56.23	2,473	25.07	2,520	3,742	6.75	227	3.92	190	3.03	211	−19	2.66	2.77	−.11	26
27	65.95	2,717	59.45	2,787	29.70	2,974	4,382	11.14	426	7.06	481	6.81	595	618	6.45	4.10	−2.35	27
28	54.40	2,303	52.47	2,331	25.35	2,630	3,860											28
29	60.33	2,526	53.05	2,456	25.24	2,580	4,021	6.44	250	1.31	122	1.26	122	300	2.44	2.77	−.33	29
30	65.32	2,670	56.66	2,585	30.11	2,982	4,105	11.93	422	5.66	248	5.91	514	429	5.68	4.10	1.58	30
31	52.88	2,220	50.26	2,340	24.97	2,519	3,712											31
32	66.59	2,699	56.06	2,524	34.82	3,550	4,204	13.83	489	6.14	257	10.80	1,123	634	8.09	6.86	1.23	32
33	68.88	2,812	57.42	2,709	30.81	3,053	3,860	16.24	612	7.84	514	8.72	808	591	8.12	6.86	1.26	33
34	52.52	2,190	49.24	2,122	22.11	2,240	3,289											34
35	63.70	2,604	54.51	2,349	35.60	3,800	4,681	10.19	364	4.54	212	12.88	1,505	1,306	9.21	6.86	2.35	35
36	66.34	2,637	53.28	2,451	25.25	2,725	4,743	9.21	369	3.22	301	4.36	431	1,281	6.11	6.86	−.75	36
37	56.06	2,328	51.43	2,277	23.93	2,402	3,549											37
38	66.91	2,700	55.98	2,514	26.25	2,687	3,552	10.65	381	3.91	199	4.59	345	201	4.36	6.86	−2.50	38
39	71.46	2,859	57.75	2,689	28.78	3,002	3,840	15.02	548	5.05	337	6.81	496	432	6.51	6.86	−.35	39
40	56.63	2,302	53.35	2,390	23.69	2,804	3,561											40
*	53.47	2,255	50.89	2,246	23.78	2,475	3,711											

*Average unfertilized yield.

MANURE TEST at Wooster—Arrangement of plots and plan of fertilizing

PLOTS ONE-SIXTEENTH ACRE

11	Nothing		Nothing	1
12	Yard manure and gypsum		Yard manure and floats	2
13	Stall manure and gypsum		Stall manure and floats	3
14	Nothing		Nothing	4
15	Yard manure, untreated	SECTION A	Yard manure and acid phos.	5
16	Stall manure, untreated		Stall manure and acid phos.	6
17	Nothing		Nothing	7
18	Chemical fertilizer		Yard manure and kainit	8
19	Chemical fertilizer		Stall manure and kainit	9
20	Nothing		Nothing	10
11	Nothing		Nothing	1
12	Yard manure and gypsum		Yard manure and floats	2
13	Stall manure and gypsum		Stall manure and floats	3
14	Nothing		Nothing	4
15	Yard manure, untreated	SECTION B	Yard manure and acid phos.	5
16	Stall manure, untreated		Stall manure and acid phos.	6
17	Nothing		Nothing	7
18	Chemical fertilizer		Yard manure and kainit	8
19	Chemical fertilizer		Stall manure and kainit	9
20	Nothing		Nothing	10
11	Nothing		Nothing	1
12	Yard manure and gypsum		Yard manure and floats	2
13	Stall manure and gypsum		Stall manure and floats	3
14	Nothing		Nothing	4
15	Yard manure, untreated	SECTION C	Yard manure and acid phos.	5
16	Stall manure, untreated		Stall manure and acid phos.	6
17	Nothing		Nothing	7
18	Chemical fertilizer		Yard manure and kainit	8
19	Chemical fertilizer		Stall manure and kainit	9
20	Nothing		Nothing	10

NORTH

TABLE 34.—Barnyard manure and chemical fertilizers on corn followed by wheat and clover in rotation at Wooster
Average annual yield and increase per acre by periods

Plot No.	Manure and treatment	26 years—1897-1923					12 years—1897-1909					14 years—1910-1923					Plot No.
		Corn*		Wheat		Clover† hay	Corn*		Wheat		Clover† hay	Corn		Wheat		Clover hay	
		Grain	Stover	Grain	Straw		Grain	Stover	Grain	Straw		Grain	Stover	Grain	Straw		
		Average annual yield per acre															
		Bu.	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	
1	None	41.81	2,298	15.85	1,748	3,258	37.15	2,222	12.82	1,517	2,781	45.80	2,363	18.46	1,946	3,565	1
2	Yard manure and floats	65.11	3,379	25.93	2,735	4,388	59.42	3,313	25.61	2,733	4,167	69.99	3,435	26.20	2,738	4,530	2
3	Stall manure and floats	67.47	3,504	27.33	2,970	4,675	63.31	3,566	27.00	2,927	4,768	71.04	3,452	27.61	3,007	4,615	3
4	None	35.09	2,012	13.77	1,553	2,721	31.03	2,009	11.25	1,298	2,049	38.57	2,015	15.92	1,772	3,154	4
5	Yard manure and acid phosphate	64.71	3,288	28.19	3,066	4,466	60.27	3,276	26.22	2,788	3,962	68.52	3,299	29.89	3,305	4,791	5
6	Stall manure and acid phosphate	67.74	3,466	28.58	3,211	4,897	64.38	3,471	26.77	2,913	4,687	70.62	3,462	30.13	3,465	5,031	6
7	None	32.57	1,925	13.34	1,538	2,691	30.83	1,970	10.26	1,220	2,036	34.05	1,886	15.98	1,810	3,112	7
8	Yard manure and kainit	58.30	3,146	23.73	2,594	3,706	54.63	3,154	21.54	2,399	3,362	61.45	3,140	25.60	2,761	3,927	8
9	Stall manure and kainit	63.34	3,336	24.86	2,840	4,185	60.07	3,495	23.33	2,712	4,206	66.15	3,200	26.17	2,950	4,172	9
10	None	35.13	1,988	13.18	1,570	2,784	32.89	2,003	10.71	1,260	2,251	37.06	1,974	15.30	1,835	3,127	10
11	None	41.64	2,311	16.84	1,890	3,467	36.83	2,333	13.86	1,678	3,016	45 77	2,292	19.40	2,073	3,758	11
12	Yard manure and gypsum	63.55	3,303	25.36	2,773	4,082	57.98	3,364	24.42	2,700	3,645	68.32	3,252	26.16	2,835	4,364	12
13	Stall manure and gypsum	63.65	3,359	25.37	2,782	4,071	60.66	3,550	24.06	2,657	3,669	66.22	3,196	26.49	2,889	4,330	13
14	None	32.83	1,951	13.81	1,520	2,753	31.57	2,007	10.77	1,216	2,012	33.90	1,903	16.42	1,781	3,230	14
15	Yard manure, untreated	55.93	2,876	22.75	2,483	3,655	51.17	2,886	19.84	2,186	2,927	60.00	2,868	25.26	2,733	4,123	15
16	Stall manure, untreated	61.89	3,150	23.84	2,638	4,151	58.16	3,304	21.34	2,349	3,588	65.09	3,019	25.99	2,885	4,513	16
17	None	40.62	2,266	13.91	1,583	2,927	36.55	2,303	11.33	1,355	2,281	44.10	2,235	16.12	1,772	3,343	17
18	Chemical fertilizer‡	51.40	2,637	18.79	2,066	3,306	43.12	2,587	14.23	1,634	2,927	58.51	2,681	22.70	2,436	3,549	18
19	Chemical fertilizer§	46.04	2,399	18.21	2,075	3,387	44.37	2,456	15.48	1,835	3,046	47.47	2,351	20.55	2,281	3,606	19
20	None	34.60	1,968	12.75	1,549	2,891	34.09	2,025	10.49	1,299	2,475	35.03	1,919	14.68	1,765	3,159	20
	Average untreated	36.78	2,089	14.18	1,605	2,937	33.87	2,108	11.44	1,325	2,362	39.29	2,073	13.53	1,845	3,306	

*Corn destroyed by grubworms in 1909.
†Soybeans grown instead of clover during first rotation and plowed under.
‡No manure—acid phosphate, 80 lb.; muriate of potash, 80 lb.; nitrate of soda, 160 lb.
§No manure—acid phosphate, 200 lb.; muriate of potash, 10 lb.; nitrate of soda, 40 lb.

TABLE 34.—Barnyard manure and chemical fertilizers on corn followed by wheat and clover in rotation at Wooster
Average annual yield and increase per acre by periods—Continued

Plot No.	Manure and treatment	26 years—1897-1923					12 years—1897-1909					14 years—1910-1923					Plot No.
		Corn*		Wheat		Clover† hay	Corn*		Wheat		Clover† hay	Corn		Wheat		Clover hay	
		Grain	Stover	Grain	Straw		Grain	Stover	Grain	Straw		Grain	Stover	Grain	Straw		
		Average annual increase per acre															
		Bu.	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	
2	Yard manure and floats	25.54	1,176	10.77	1,052	1,309	24.31	1,162	13.31	1,289	1,630	26.60	1,188	8.59	850	1,103	2
3	Stall manure and floats	30.14	1,397	12.87	1,352	1,775	30.24	1,486	15 23	1,556	2,475	30.06	1,321	10.84	1,178	1,325	3
5	Yard manure and acid phosphate	30.46	1,305	14.56	1,519	1,755	29.30	1,280	15.30	1,516	1,918	31.46	1,325	13.94	1,522	1,651	5
6	Stall manure and acid phosphate	34.33	1,512	15.10	1,668	2,196	33.48	1,487	16.18	1,668	2,647	35.07	1,533	14.16	1,667	1,906	6
8	Yard manure and kainit	24.88	1,201	10.44	1,046	984	23.11	1,172	11.14	1,166	1,254	26.40	1,226	9.85	943	810	8
9	Stall manure and kainit	29.06	1,369	11.62	1,281	1,432	27.86	1,503	12.77	1,465	2,026	30.10	1,256	10.63	1,124	1,050	9
12	Yard manure and gypsum	24.84	1,113	9.52	1,006	853	22.90	1,140	11.59	1,177	963	26.51	1,090	7.76	860	782	12
13	Stall manure and gypsum	27.89	1,288	10.55	1,138	1,080	27.34	1,434	12.27	1,287	1,322	28.36	1,164	9.08	1,011	924	13
15	Yard manure, untreated	20.50	820	8.90	942	844	17.94	781	8.88	925	826	22.70	854	8.94	956	856	15
16	Stall manure, untreated	23.87	989	9.97	1,076	1,281	23.27	1,101	10.20	1,040	1,396	24.39	893	9.77	1,107	1,207	16
18	Chemical fertilizer‡	12.83	470	5.27	494	390	7.39	377	3.18	298	582	17.43	551	7.07	662	267	18
19	Chemical fertilizer§	9.43	332	5.07	514	484	9.46	337	4.71	517	635	9.41	328	5.39	511	387	19

*Corn destroyed by grubworms in 1909.
†Soybeans grown instead of clover during first rotation and plowed under.
‡No manure—acid phosphate, 80 lb.; muriate of potash, 80 lb.; nitrate of soda, 160 lb.
§No manure—acid phosphate, 200 lb.; muriate of potash, 10 lb.; nitrate of soda, 40 lb.

TABLE 35.—Barnyard manure and chemical fertilizers on corn followed by wheat and clover in rotation
Value of total produce and of increase per rotation

Plot No.	Manure and treatment	Value per acre of three crops of rotation		Value of increase due to treatment				Plot No.
				Per rotation per acre		Per ton manure		
		First period	Second period	First period	Second period	First period	Second period	
1	None	$69.03	$88.03	.....	.....	.....	.....	1
2	Yard manure and floats	113.57	124.60	$48.68	$40.56	$6.08	$5.07	2
3	Stall manure and floats	123.31	128.10	62.57	48.07	7.82	6.01	3
4	None	56.60	76.04	.....	.....	.....	.....	4
5	Yard manure and acid phosphate	113.28	130.30	57.18	55.46	7.15	6.93	5
6	Stall manure and acid phosphate	122.97	134.61	67.35	61.00	8.42	7.62	6
7	None	55.09	72.40	.....	.....	.....	.....	7
8	Yard manure and kainit	98.88	112.84	42.57	39.79	5.32	4.97	8
9	Stall manure and kainit	112.44	119.14	54.89	46.52	6.86	5.81	9
10	None	58.77	74.22	.....	.....	.....	.....	10
11	None	72.29	90.54	.....	.....	.....	.....	11
12	Yard manure and gypsum	107.50	121.93	40.63	37.05	5.08	4.63	12
13	Stall manure and gypsum	109.56	120.53	48.12	41.30	6.01	5.16	13
14	None	56.00	73.58	.....	.....	.....	.....	14
15	Yard manure, untreated	90.29	112.18	31.90	35.77	3.99	4.47	15
16	Stall manure, untreated	103.09	120.16	42.31	40.89	5.29	5.11	16
17	None	63.17	82.08	.....	.....	.....	.....	17
18	Chemical fertilizer*	76.92	103.07	14.40	24.30	.....	.....	18
19	Chemical fertilizer†	80.11	92.40	18.23	16.98	.....	.....	19
20	None	61.22	72.10	.....	.....	.....	.....	20
	Average unmanured yields	60.43	78.63	.....	.....	.....	.....	.....

*No manure: acid phosphate, 80 lb.; muriate of potash, 80 lb.; nitrate of soda, 160 lb.
†No manure: acid phosphate, 200 lb.; muriate of potash, 10 lb.; nitrate of soda, 40 lb. (Previous to 1918 same quantities of elements, but nitrogen and part of phosphorus in tankage.)

PLAN OF FERTILIZING IN POTATOES-WHEAT-CLOVER ROTATION

PLOTS ONE-TENTH ACRE — Fertilizing materials per acre

Plot No.	On Potatoes			On Wheat			
	Acid phosphate	Muriate potash	Nitrate soda	Acid phosphate	Muriate potash	Dried blood	Nitrate soda
1	..	..	..	....		....	...
2	160	....	.	160	...	....	....
3	....	100	...	....	100	....	.
4	..	....	....		...	.	....
5	....	....	80	....		50	120
6	160	....	80	160	...	50	120
7	...	..			...	...	....
8	160	100	.	160	100		
9	....	100	80	....	100	50	120
10	....	....	....	. .	...	....	.
11	160	100	80	160	100	50	120
12	160	100	160	160	100	50	200
13	..	...		.	.	...	...
14	320	200	160	160	100	50	120
15	480	300	320			....	.. .
16	.						
17	...	....	....	Manure, 4 tons on wheat			
18	....	....	....	Manure, 8 tons on wheat			
19	....	....	....	....	. .	....	....
20	160	100	80	160	100	25	60
21	Same elements as 20, but nitrogen in oilmeal						
22	....	....	....	....	. ..	....	....
23	Same elements as 20, but nitrogen in dried blood						
24	Same elements as 20, but nitrogen in sulphate ammonia						
25	....	....	...	....	....	....	....
26	Same elements as 11, but phosphorus in bonemeal						
27	Same elements as 20, but nitrogen in nitrate of lime*						
28	....	....	....	....	....	....	....
29	Same elements as 11, but phosphorus in basic slag						
30	Manure, 8 tons on potatoes			....	....	....	....
31	....	....	....	....	...	....	....
32	....	....	....	Manure, 16 tons on wheat			
33	Same elements as 20, but nitrogen in tankage						
34	....	....	....	....	....	....	....

*Since 1910—previously same elements as 11, with phosphorus in dissolved boneblack.

TABLE 36.—Potatoes, wheat, and clover grown in 3-year rotation at Wooster
Average annual yield per acre by periods

Plot	Total fertilizing materials applied to potatoes and wheat. None on clover	Potatoes			Wheat						Clover		
		30 years 1894–1923	15 years 1894–1908	15 years 1909–1923	29 years 1895–1923		15 years 1895–1909		14 years 1910–1923		27 crops* 1896–1923	15 crops* 1896–1910	13 years 1911–1923
					Grain	Straw	Grain	Straw	Grain	Straw			
No.	*Pounds per acre*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1	None	128.51	166.05	90.95	29.45	2,959	31.14	3,209	27.64	2,690	3,972	4,334	3,582
2	Acid phosphate, 320	135.12	182.62	87.59	35.74	3,626	36.61	3,836	34.82	3,401	4,288	4,574	3,980
3	Muriate potash, 200	145.13	178.79	111.51	30.94	2,876	33.12	3,100	28.61	2,637	4,054	4,216	3,880
4	None	128.99	170.87	87.12	29.05	2,823	31.15	3,060	26.80	2,570	3,910	3,930	3,888
5	Nitrate soda, 200; dried blood, 50	133.41	175.49	91.33	29.69	3,116	31.42	3,278	27.84	2,943	4,251	4,207	4,298
6	Acid phosphate, 320; nitrate soda, 200; dried blood, 50	140.99	182.74	99.24	35.85	3,673	36.88	3,922	34.74	3,406	4,398	4,352	4,447
7	None	122.30	157.48	87.11	27.63	2,692	29.08	2,840	26.07	2,532	3,804	3,813	3,794
8	Acid phosphate, 320; muriate potash, 200	156.65	189.09	124.21	36 16	3,349	36.34	3,390	35.97	3,305	4,148	4,151	4,145
9	Muriate potash, 200; nitrate soda, 200; dried blood, 50	144.88	171.52	118.26	32.75	3,127	35.20	3,321	30.13	2,919	4,195	4,339	4,040
10	None	121.24	160.30	82.18	28.34	2,633	30.32	2,831	26.22	2,421	3,566	3,740	3,378
11	Acid phos., 320; mur. pot., 200; nit. soda, 200; dried blood, 50	154.13	184.08	124.18	37.92	3,792	38.94	3,839	36.82	3,743	4,261	4,275	4,246
12	Acid phos., 320; mur. pot., 200; nit. soda, 360; dried blood, 50	159.91	191.27	128.55	38.18	3,893	38.72	3,984	37.60	3,796	4,436	4,482	4,385
13	None	125.27	159.09	91.44	27.97	2,592	29.69	2,778	26.12	2,395	3,690	3,880	3,485
14	Acid phos., 480; mur. pot., 300; nit. soda, 280; dried blood, 50	165.16	191.49	138.84	38.50	3,979	38.64	3,961	38.35	3,998	4,384	4,430	4,335
15	Acid phos., 480; mur. pot., 300; nit. soda, 320. On potatoes only	161.94	187.82	136.06	36.95	3,610	37.33	3,639	36.53	3,580	4,290	4,400	4,171
16	None	118.99	148.53	89.45	27.27	2,570	28.16	2,551	26.33	2,591	3,470	3,590	3,341
17	Yard manure, 4 tons; on wheat only	132.69	162.07	103.31	32.19	3,140	32.20	3,167	32.17	3,111	4,186	4,208	4,162

*Crop for 1909 not included.
†Since 1910. Previously same as 11, but phosphorus in dissolved boneblack.
‡Fertilizing discontinued 1921.

TABLE 36.—Potatoes, wheat, and clover grown in 3-year rotation at Wooster
Average annual yield per acre by periods—Continued

Plot	Total fertilizing materials applied to potatoes and wheat. None on clover	Potatoes			Wheat						Clover		
		30 years 1894–1923	15 years 1894–1923	15 years 1909–1923	29 years 1895–1923		15 years 1895–1909		14 years 1910–1923		27 crops* 1896–1923	14 crops* 1896–1910	13 years 1911–1923
					Grain	Straw	Grain	Straw	Grain	Straw			
No.	*Pounds per acre*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
18	Yard manure, 8 tons; on wheat only	142.74	168.94	116.54	34.03	3,393	33.27	3,247	34.85	3,548	4,568	4,613	4,521
19	None	118.18	145.64	90.72	24.43	2,324	25.37	2,464	23.41	2,174	3,246	3,332	3,154
20	Acid phos., 320 mur. pot., 200; nit. soda, 140; dried blood, 25	157.19	188.73	125.65	35.53	3,515	34.65	3,422	36.48	3,617	4,144	4,191	4,088
21	Same elements as 20, but nitrogen in oilmeal	153.22	180.46	125.98	34.85	3,378	34.78	3,316	34.92	3,444	3,725	3,792	3,653
22	None	116.58	148.15	84.59	23.39	2,202	25.07	2,278	21.59	2,119	3,135	3,359	2,894
23	Same elements as 20, but nitrogen in dried blood	153.26	181.93	124.59	35.04	3,326	35.46	3,368	34.59	3,281	3,725	3,819	3,623
24	Same elements as 20, but nitrogen in sulphate ammonia	153.85	181.60	126.11	35.54	3,353	35.44	3,296	35.65	3,415	3,724	3,817	3,625
25	None	114.33	147.55	81.12	23.64	2,241	25.51	2,381	21.63	2,092	3,199	3,413	2,970
26	Same elements as 11, but phosphorus in bonemeal	149.27	176.48	122.06	34.30	3,356	36.13	3,452	32.34	3,254	4,059	4,188	3,919
27	Same elements as 20, but nitrogen in nitrate of lime†	152.25	182.98	121.52	36.38	3,663	37.35	3,747	35.35	3,573	3,957	4,008	3,902
28	None	114.40	149.42	79.38	23.53	2,308	25.57	2,479	21.35	2,125	3,397	3,532	3,251
29	Same elements as 11, but phosphoric in basic slag	153.19	180.87	125.50	36.29	3,724	37.80	3,772	34.67	3,673	4,419	4,429	4,409
30	Yard manure, 8 tons, on potatoes only	160.61	193.23	128.01	30.93	3,079	32.53	3,158	29.22	2,994	4,333	4,361	4,302
31	None	120.57	156.16	84.97	23.50	2,344	25.42	2,468	21.44	2,212	3,489	3,456	3,519
32	Yard manure, 16 tons, on wheat only	170.27	180.09	160.45	35.39	3,846	34.93	3,550	35.90	4,163	5,154	5,162	5,145
33	Same elements (since 1899) as 20, but nitrogen in tankage‡	146.41	173.13	119.60	34.02	3,234	34.86	3,230	33.11	3,238	4,020	4,088	3,947
34	None	115.15	138.97	91.33	23.47	2,297	24.63	2,300	22.24	2,293	3,330	3,498	3,148
O	Average unfertilized yield	120.38	154.02	86.70	25.97	2,504	27.59	2,643	24.24	2,355	3,521	3,656	3,375

*Crop for 1909 not included.
†Since 1910. Previously same as 11, but phosphorus in dissolved boneblack.
‡Fertilizing discontinued 1921.

TABLE 37.—Potatoes, wheat, and clover grown in 3-year rotation at Wooster
Average annual increase per acre by periods

Plot	Potatoes			Wheat						Clover			Plot
				29 years 1895–1923		15 years 1895–1905		14 years 1910–1923					
	30 years 1894–1923	15 years 1894–1908	15 years 1909–1923	Grain	Straw	Grain	Straw	Grain	Straw	27 crops* 1895–1923	14 crops* 1895–1923	13 years 1911–1923	
No.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*No.*
2	6.45	14.96	−2.08	6.43	712	5.47	677	7.46	750	337	375	296	2
3	16.30	9.52	23.10	1.76	8	1.99	−9	1.53	26	123	151	94	3
5	6.65	9.08	4.21	1.12	337	.96	292	1.29	385	376	316	440	5
6	16.46	20.79	12.13	7.74	937	7.11	1,009	8.43	861	558	500	621	6
8	34.70	30.66	38.75	8.30	676	6.85	552	9.85	809	423	362	489	8
9	23.28	12.16	34.44	4.65	474	5.29	487	3.97	460	549	574	523	9
11	31.55	24.18	38.91	9.70	1,173	8.83	1,026	10.62	1,330	654	488	832	11
12	35.98	31.71	40.20	10.09	1,287	8.82	1,189	11.44	1,392	787	650	936	12
14	41.99	35.91	48.07	10.76	1,394	9.48	1,259	12.17	1,538	768	647	898	14
15	40.86	35.77	45.95	9.44	1,033	8.67	1,012	10.28	1,054	746	714	781	15
17	14.02	14.58	13.44	5.86	652	4.96	645	6.81	659	792	705	885	17
18	24.30	22.36	26.24	8.65	986	6.96	751	10.47	1,235	1,246	1,195	1,305	18
20	39.54	42.26	36.83	11.45	1,231	9.38	1,019	13.67	1,459	932	850	1,020	20
21	36.11	33.15	39.07	11.11	1,135	9.61	976	12.72	1,308	553	442	673	21
23	37.43	33.98	40.88	11.56	1,112	10.24	1,057	12.99	1,171	568	442	704	23
24	38.77	33.85	43.70	11.98	1,126	10.07	951	14.03	1,314	547	422	681	24
26	34.92	28.31	41.53	10.69	1,093	10.60	1,039	10.80	1,151	793	735	856	26
27	37.87	34.18	41.56	12.81	1,377	11.80	1,302	13.90	1,459	626	516	745	27
29	36.73	29.20	44.26	12.77	1,404	12.28	1,297	13.28	1,519	992	922	1,069	29
30	42.10	39.32	44.90	7.42	746	7.06	686	7.81	811	876	880	872	30
32	51.51	29.66	73.35	11.90	1,528	9.77	1,138	14.19	1,924	1,718	1,691	1,750	32
33	29.45	28.43	30.48	10.53	921	9.97	874	11.14	971	638	604	675	33

*Crop for 1909 not included.

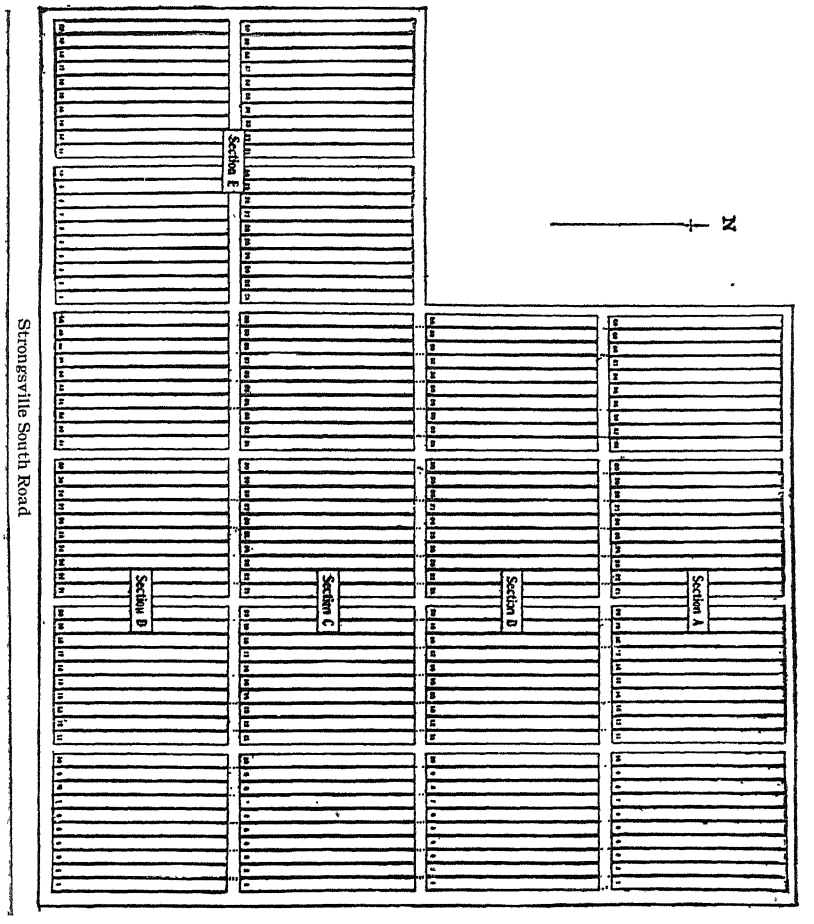
TABLE 38.—Potatoes, wheat, and clover grown in rotation at Wooster Fertilizing constituents, total and net values of increase, all per acre per rotation

Plot No.	Fertilizing constituents			Cost of fertilizers	Total value of increase			Net value of increase			Plot No.
	Ammonia	Phosphoric acid	Potash		30 years 1894-1923	First period	Last period	30 years 1894-1923	First period	Last period	
	Lb.	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	
2	.....	45	.....	3.20	13.95	17.44	10.51	10.75	14.24	7.31	2
3	.....	.....	100	5.00	10.84	7.85	13.84	5.84	2.85	8.84	3
5	45	.....	.....	8.40	8.10	8.60	7.65	—.30	.20	—.75	5
6	45	45	.....	11.60	22.49	23.77	21.29	10.89	12.17	9.69	6
8	.....	45	100	8.20	30.52	26.30	34.90	22.32	18.10	26.70	8
9	45	.....	100	13.40	21.58	16.89	26.25	8.18	3.49	12.85	9
11	45	45	100	16.60	33.30	27.14	39.63	16.70	10.54	23.03	11
12	75	45	100	22.20	37.19	32.51	42.04	14.99	10.31	19.84	12
14	60	68	150	23.50	41.00	35.40	46.78	17.50	11.90	23.28	14
15	60	68	150	23.50	38.04	34.46	41.73	14.54	10.96	18.23	15
17[1]	30	20	25	.....	20.44	19.14	21.81	.....	.....	.....	17
18[1]	60	40	50	.....	32.60	28.97	36.46	.....	.....	.....	18
20	23	45	100	13.80	41.29	39.43	43.38	27.49	25.63	29.58	20
21[2]	23	45	100	13.80	36.16	31.93	40.60	22.36	18.13	26.80	21
23[3]	23	45	100	13.80	37.31	33.18	41.64	23.51	19.38	27.84	23
24[4]	23	45	100	13.80	38.26	32.59	44.26	24.46	18.79	30.46	24
26[5]	45	45	100	16.60	36.82	32.88	40.86	20.22	16.28	24.26	26
27[6]	23	45	100	13.80	39.87	36 01	43.86	26.07	22.21	30.06	27
29[7]	45	45	100	16.60	42.08	37.03	47.22	25.48	20.43	30.62	29
30[1]	60	40	50	.....	36.90	35.03	38.83	... .	.....	.....	30
32[1]	120	80	100	.....	54.35	40.12	68.79	.....	.....	.....	32
33[8]	23	45	100	13.80	32.33	30.89	33.81	18.53	17.09	20.01	33

[1]Elements in manure, [2]Nitrogen in oilmeal, [3]Nitrogen in dried blood, [4]Nitrogen in sulphate ammonia, [5]Phosphorus in bonemeal, [6]Nitrogen in nitrate of lime since 1910, [7]Phosphorus in basic slag, [8]Nitrogen in tankage to 1921—unfertilized since.

ARRANGEMENT OF PLOTS IN 5-YEAR ROTATION AT STRONGSVILLE

Plots one-tenth acre



PLAN OF FERTILIZING IN 5-YEAR ROTATION AT STRONGSVILLE

Plots one-tenth acre—Fertilizing materials in pounds per acre

Plot No.	On corn			On oats			On wheat			
	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Dried blood	Nitrate of soda
Roadway										
1	....	....	....	....	....	....	....	....	....	....
2	80	....	....	80	....	....	160	....	....	....
3	..	80	....	....	80	....	....	100	....	....
4	....	....	....	....	....	....	....	....	....	....
5	....	....	160	....	....	160	....	....	50	120
6	80	....	160	80	....	160	160	....	50	120
7	....	....	....	....	....	....	....	....	....	....
8	80	80	....	80	80	....	160	100	....	....
9	....	80	160	....	80	160	....	100	50	120
10	....	....	....	....	....	....	....	....	....	....
Roadway										
11	80	80	160	80	80	160	160	100	50	120
12	80	80	240	80	80	240	160	100	50	200
13	....	.. .	....	....	....	....	....	....	....	....
14	80	80	160	....	....	....	160	100	50	120
15	....	....	....	....	....	....	160	100	50	120
16	....	....	....	....	....	....	....	....	....	....
17	160	80	80	160	80	80	160	100	25	60
18	Barnyard manure, 8 tons each, on corn and wheat									
19	....	.. .	....	....	....	....	....	....	....	....
20	Barnyard manure, 4 tons each, on corn and wheat									
Roadway										
21	Same elements as 17, but nitrogen in oilmeal									
22	....	....	....	....	....	....	....	....	.	....
23	Same elements as 17, but nitrogen in dried blood									
24	Same elements as 17, but nitrogen in sulphate ammonia									
25	.. .	....	....	....	....	....	. .	. .	....	.
26	Same elements as 11, but phosphorus in bonemeal									
27	Same elements as 17, but nitrogen in nitrate of lime									
28	....	....	....	....	....	....	....	..	....	....
29	Same elements as 11, but phosphorus in basic slag									
30	Same elements as 17, but nitrogen in tankage									
Roadway										
31	....	...	...	....	....	....	....	....	....	..
32	Acid phosphate and muriate potash as 11, nitrate soda one-half as much									
33	Acid phosphate and muriate potash as 11, nitrate soda one-fourth as much									
34	....	....	....	....	....	....	....	....	....	...
35	Acid phosphate and nitrate soda as 11, muriate potash one-half as much									
36	Acid phosphate and nitrate soda as 11, muriate potash one-fourth as much									
37	....	....	....	....	....	....	....	....	....	....
38	Acid phosphate 100, muriate potash 10, tankage (7-30) 100, all on wheat									
39	Barnyard manure, 16 tons, all on wheat									
40	....	....	....	....	....	....	...	....	...	....
Roadway										

Roadway

Roadway

TABLE 39.—Strongsville 5-year rotation, limed land—Average annual yield per acre and increase from fertilizers 1905-1923

Plot	Corn—15 crops				Oats—15 crops				Wheat—13 crops				Hay				Annual value per acre		Plot
	Grain		Stover		Grain		Straw		Grain		Straw		Clover—14 crops		Soybean—6 crops				
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*No.*
1	23.53	.....	1,569	.....	31.37	.....	1,175	.....	11.36	.....	1,099	.....	1,673	.....	1,939	.....	15.41	.....	1
2	34.02	11.44	1,878	319	45.46	15.17	1,567	484	22.29	11.51	2,020	984	3,014	1,388	2,333	365	23.61	8.65	2
3	23.01	1.40	1,645	96	33.33	4.12	1,085	95	11.42	1.24	1,022	49	1,595	17	1,911	—83	15.31	.80	3
4	20.65	.....	1,539	.....	28.12	.....	897	.....	9.60	.....	910	.....	1,530	.....	2,022	.....	14.06	.....	4
5	23.42	.48	1,636	13	31.19	1.34	1,055	113	10.03	—.33	1,040	70	1,778	102	2,238	50	15.67	.43	5
6	36.89	11.68	2,038	330	44.66	13.07	1,540	552	26.83	15.72	2,455	1,425	2,838	1,016	2,603	250	25.28	8.88	6
7	27.50	.....	1,792	.....	33.32	.....	1,033	.....	11.87	.....	1,089	.....	1,967	.....	2,519	.....	17.57	.....	7
8	39.97	12.44	2,307	496	49.11	15.45	1,838	749	25.22	12.94	2,082	482	2,736	822	3,055	610	26.37	8.83	8
9	26.81	—.74	1,915	87	40.29	6.28	1,325	180	15.13	2.47	1,452	341	2,135	274	2,431	60	19.20	1.70	9
10	27.58	.....	1,846	.....	34.35	.....	1,201	.....	13.06	.....	1,121	.....	1,808	.....	2,297	.....	17.46	.....	10
11	41.75	15.09	2,437	659	52.87	18.79	1,867	667	28.95	16.24	2,757	1,612	2,754	959	2,973	703	27.99	10.83	11
12	44.30	18.56	2,541	831	54.67	20.84	1,877	678	30.55	18.19	2,911	1,741	3,004	1,222	2,676	434	28.87	12.00	12
13	24.82	.....	1,641	.....	33.56	.....	1,197	.....	12.01	.....	1,194	.....	1,770	.....	2,216	.....	16.56	.....	13
14	32.82	6.96	1,970	271	38.24	3.91	1,286	87	27.95	15.63	2,592	1,399	2,653	841	2,487	210	23.88	6.87	14
15	28.52	1.62	1,834	78	36.02	.91	1,263	62	28.02	15.39	2,566	1,375	2,546	691	2,347	8	22.65	5.18	15
16	27.93	.....	1,814	.....	35.89	.....	1,203	.....	12.93	.....	1,190	.....	1,898	.....	2,402	.....	17.92	.....	16
17	45.38	17.03	2,499	681	55.34	18.67	1,935	669	29.58	16.53	2,624	1,452	3,272	1,308	3,349	965	30.16	12.00	17
18	45.30	16.52	2,579	764	48.58	11.45	1,789	459	23.47	10.32	2,383	1,229	3,301	1,272	3,411	1,046	28.40	10.00	18
19	29.20	.....	1,825	.....	38.21	.....	1,393	.....	13.26	.....	1,135	.....	2,095	.....	2,348	.....	18.64	.....	19
20	40.27	11.31	2,326	496	47.45	8.56	1,746	355	20.89	7.53	1,897	717	2,961	789	3,015	547	25.56	6.56	20

TABLE 39.—Strongsville 5-year rotation, limed land—Average annual yield per acre and increase from fertilizers 1905-1923—Continued

Plot	Corn—15 crops				Oats—15 crops				Wheat—13 crops				Hay				Annual value per acre		Plot
	Grain		Stover		Grain		Straw		Grain		Straw		Clover—14 crops		Soybean—6 crops				
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*No.*
21	45.97	17.26	2,550	715	58.29	18.71	2,179	790	29.50	16.04	2,735	1,508	3,288	1,038	3,442	853	30.83	11.46	21
22	28.47	.....	1,841	.....	40.26	.....	1,386	.....	13.55	.....	1,273	.....	2,325	.....	2,710	.....	19.72	.....	22
23	42.82	14.27	2,332	454	56.17	15.73	2,101	684	27.31	13.71	2,637	1,339	3,174	921	3,367	734	29.30	9.72	23
24	42.50	13.87	2,483	567	56.65	16.03	2,143	695	27.24	13.60	2,556	1,235	3,415	1,234	3,251	695	29.52	10.09	24
25	28.71	.....	1,953	.....	40.80	.....	1,478	.....	13.68	.....	1,346	.....	2,110	.....	2,479	.....	19.29	.....	25
26	38.83	10.88	2,407	502	52.43	13.08	1,918	530	25.07	11.54	2,247	918	3,283	1,165	3,112	633	27.52	8.55	26
27	39.27	12.08	2,412	555	53.80	15.89	1,820	521	27.54	14.16	2,560	1,249	3,154	1,026	3,093	616	28.08	9.42	27
28	26.43	.....	1,810	.....	36.47	.....	1,208	.....	13.23	.....	1,294	.....	2,137	.....	2,476	.....	18.34	.....	28
29	38.01	12.67	2,302	529	52.01	15.99	1,725	511	28.29	15.54	2,592	1,370	2,890	909	3,206	850	27.59	10.00	29
30	39.99	15.75	2,325	589	51.82	16.24	1,784	563	25.61	13.33	2,235	1,087	3,165	1,304	3,201	964	27.60	10.75	30
31	23.15	.....	1,698	.....	35.13	.....	1,227	.....	11.81	.....	1,076	.....	1,669	.....	2,117	.....	16.09	.....	31
32	34.95	11.92	2,235	546	51.69	16.58	1,899	690	27.13	15.40	2,380	1,305	2,700	995	2,474	343	25.47	8.35	32
33	36.45	13.54	2,176	496	50.42	15.34	1,827	636	26.17	14.53	2,470	1,396	2,781	1,041	2,778	632	25.94	9.80	33
34	22.79	.....	1,671	.....	35.05	.....	1,173	.....	11.56	.....	1,073	.....	1,775	.....	2,160	.....	16.17	.....	34
35	36.57	13.30	2,169	454	50.08	15.85	1,912	749	27.94	16.70	2,493	1,444	2,953	1,178	2,799	558	26.63	10.40	35
36	34 54	10.80	2,114	355	49.40	15.98	1,742	588	26.71	15.80	2,453	1,429	2,900	1,127	2,711	391	26.70	9.41	36
37	24.21	.....	1,803	.....	32.59	.....	1,144	.....	10.59	.....	1,001	.....	1,773	.....	2,400	.....	16.35	.....	37
38	31.53	6.76	2,067	283	35.84	3.63	1,312	178	21.68	10.62	1,841	811	2,691	821	2,707	227	22.32	5.57	38
39	38.16	12.84	2,216	450	40.09	8.27	1,396	272	21.54	10.01	2,102	1,043	3,779	1,811	3,411	852	26.50	9.34	39
40	25.87	.....	1,747	.....	31.43	.....	1,112	.....	11.99	.....	1,088	.....	2,065	.....	2,639	.....	17.56	.....	40
0	25.77	.....	1,753	.....	34.75	.....	1,202	.....	12.18	.....	1,131	.....	1,900	.....	2,337	.....	17.12	.....	0

TABLE 40.—Strongsville 5-year rotation, floats-treated land—Average annual yield per acre and increase from fertilizers 1905-23

Plot	Corn—15 crops				Oats—15 crops				Wheat—13 crops				Hay				Annual value per acre		Plot
	Grain		Stover		Grain		Straw		Grain		Straw		Clover—14 crops		Soybean—6 crops				
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*No.*
1	31.42	.....	1,982	.....	41.19	.....	1,461	.....	15.71	.....	1,495	.....	2,859	.....	2,253	.....	20.97	.....	1
2	29.15	—.19	1,798	—19	49.10	6.43	1,570	112	19.10	3.13	1,686	216	2,892	28	1,955	—216	21.63	0.99	2
3	23.88	—3.39	1,690	37	44.15	0	1,467	12	15.48	—.73	1,359	—87	2,717	—152	1,945	—142	19.22	—1.08	3
4	25.19	.....	1,488	.....	45.62	.....	1,451	.....	16.47	.....	1,421	.....	2,874	.....	2,005	.....	19.97	.....	4
5	32.10	3.51	1,757	102	50.65	3.72	1,679	158	19.61	2.90	1,819	334	3,450	355	2,445	175	23.94	2.46	5
6	38.61	6.61	1,991	168	57.49	9.24	1,950	360	26.91	9.98	2,465	916	3,673	356	2,769	233	28.25	5.27	6
7	35.40	.....	1,990	.....	49.56	.....	1,659	.....	17.15	.....	1,613	.....	3,539	.....	2,801	.....	24.49	.....	7
8	43.98	7.60	2,514	491	53.81	4.25	2,027	331	23.83	5.80	2,076	411	3,708	248	3,067	276	28.69	3.97	8
9	46.61	9.26	2,563	508	57.25	7.69	2,017	285	26.49	7.58	2,510	797	3,889	506	2,837	66	30.04	5.08	9
10	38.33	.....	2,087	.....	49.56	.....	1,769	.....	19.78	.....	1,764	.....	3,306	.....	2,755	.....	25.20	.....	10
11	44.04	6.63	2,416	352	61.68	12.31	2,152	373	31.31	11.65	2,858	1,094	3,665	371	2,959	217	31.00	6.03	11
12	46.50	10.02	2,579	538	61.11	11.93	2,187	399	32.03	12.49	3,174	1,410	3,650	368	2,894	166	31.59	6.83	12
13	35.56	.....	2,018	.....	48.99	.....	1,798	.....	19.42	.....	1,764	.....	3,270	.....	2,714	.....	24.50	.....	13
14	43.58	8.81	2,448	486	50.91	4.13	1,858	158	29.74	10.93	2,783	1,093	3,630	433	3,410	800	30.23	6.47	14
15	36.44	2.48	2,015	110	48.37	3.81	1,715	112	27.91	9.76	2,604	984	3,356	232	2,768	263	26.92	3.95	15
16	33.15	.....	1,849	.....	42.34	.....	1,506	.....	17.61	.....	1,542	.....	3,050	.....	2,400	.....	22.17	.....	16
17	44.35	11.31	2,440	564	55.35	11.73	1,969	450	27.14	9.92	2,412	890	3,966	899	2,765	278	29.57	7.22	17
18	47.39	14.52	2,543	639	51.80	6.90	1,890	358	24.66	7.85	2,314	813	4,274	1,189	3,023	448	30.03	7.51	18
19	32.73	.....	1,931	.....	46.19	.....	1,545	.....	16.41	.....	1,481	.....	3,102	.....	2,661	.....	22.68	.....	19
20	40.44	7.51	2,300	364	50.40	3.38	2,048	433	21.15	4.28	2,017	474	3,760	560	2,996	318	27.24	4.13	20

TABLE 40.—Strongsville 5-year rotation, floats-treated land—Average annual yield per acre and increase from fertilizers 1905-23—Continued

Plot	Corn—15 crops				Oats—15 crops				Wheat—13 crops				Hay				Annual value per acre		Plot
	Grain		Stover		Grain		Straw		Grain		Straw		Clover—14 crops		Soybean—6 crops				
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*No.*
21	39.71	6.59	2,834	441	58.65	10.79	2,230	544	26.41	9.09	2,554	949	3,424	127	3,038	344	28.80	5.28	21
22	33.32	.....	1,948	.....	48.70	.....	1,756	.....	17.77	.....	1,667	.....	3,395	.....	2,710	.....	23.96	.....	22
23	40.41	7.88	2,353	408	58.99	10.48	2,368	610	26.75	9.27	2,550	879	3,556	231	3,012	322	29.20	5.57	23
24	36.03	4.28	2,217	276	57.84	9.52	2,340	580	25.70	8.51	2,303	628	3,185	—70	2,974	303	27.48	4.17	24
25	30.96	.....	1,938	.....	48.13	.....	1,762	.....	16.89	.....	1,678	.....	3,186	.....	2,651	.....	23.00	.....	25
26	40.40	9.52	2,354	457	59.84	12.65	2,308	601	26.66	10.08	2,446	866	3,554	410	2,986	395	29.14	6.53	26
27	36.86	6.02	2,218	361	55.53	9.29	2,070	417	28.42	7.13	2,183	701	3,344	241	2,543	11	26.35	4.13	27
28	30.73	.....	1,816	.....	45.29	.....	1,598	.....	15.98	.....	1,384	.....	3,061	.....	2,472	.....	21.82	.....	28
29	42.87	11.22	2,356	457	56.41	11.13	1,993	381	27.16	10.77	2,581	1,159	3,693	613	2,793	254	29.14	6.91	29
30	41.54	8.97	2,344	363	53.25	7.97	1,884	258	25.60	8.81	2,376	915	3,509	409	2,604	0	27.67	5.04	30
31	33.48	.....	2,063	.....	45.27	.....	1,640	.....	17.20	.....	1,499	.....	3,118	.....	2,671	.....	23.03	.....	31
32	40.73	8.08	2,468	466	55.25	10.25	1,991	381	25.45	8.42	2,414	921	3,466	459	3,271	588	28.75	6.09	32
33	37.71	5.89	2,351	410	54.80	10.06	1,980	401	24.47	7.61	2,225	737	3,494	599	3,071	376	27.68	5.39	33
34	30.99	.....	1,880	.....	44.47	.....	1,549	.....	16.70	.....	1,483	.....	2,784	.....	2,707	.....	21.93	.....	34
35	41.48	9.84	2,326	426	59.00	13.46	2,226	599	28.24	11.38	2,718	1,221	3,510	613	2,956	282	29.50	7.20	35
36	42.53	10.23	2,418	499	58.64	12.04	2,314	608	28.60	11.56	2,606	1,095	3,666	656	2,902	263	29.89	7.19	36
37	32.95	.....	1,938	.....	47.68	.....	1,784	.....	17.20	.....	1,525	.....	3,122	.....	2,606	.....	23.08	.....	37
38	31.25	.71	1,863	28	45.11	.37	1,638	—19	21.90	5.60	1,955	533	3,279	270	2,774	170	24.17	2.38	38
39	34.87	6.73	2,004	273	45.38	3.58	1,760	230	22.70	7.31	2,295	974	4,436	1,541	3,086	482	27.36	6.46	39
40	25.72	.....	1,627	.....	38.86	.....	1,403	.....	14.50	.....	1,218	.....	2,782	.....	2,603	.....	19.80	.....	40
O	32.14	.....	1,897	.....	45.86	.....	1,620	.....	17.08	.....	1,539	.....	3,103	.....	2,572	.....	22.62	.....	O

TABLE 41.—Strongsville 5-year rotation—Total fertilizing materials and total value of yield and of increase from fertilizers, 1905-1923 (Section E and timothy crop excluded)

Plot	Total fertilizing materials				Total value of produce		Assumed unlimed yield	Increase over limestone		
	Acid phosphate	Muriate of potash	Nitrate of soda	Cost	Limed	Floats treated		Increase from fertilizer	Increase from fertilizers and floats	Increase from floats alone
No.	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
1	.....	.....	.....	.....	985	1,360	649	.....	.....	.....
2	4,560	.....	.....	46	1,536	1,422	1,200	585	807	222
3	.....	3,720	.....	93	979	1,252	643	62	671	609
4	.....	.....	.....	.....	883	1,301	547	.....	.....	.....
5	.....	.....	6,880	241	986	1,556	650	29	935	906
6	4,560	.....	6,880	287	1,633	1,838	1,297	603	1,144	541
7	.....	.....	.....	.....	1,104	1,579	768	.....	.....	.....
8	4,560	3,720	.....	139	1,690	1,859	1,354	584	1,089	505
9	.....	3,720	6,880	334	1,222	1,967	886	115	1,196	1,081
10	.....	.....	.....	.....	1,109	1,630	773	.....	.....	.....
11	4,560	3,720	6,880	380	1,806	2,022	1,470	717	1,269	552
12	4,560	3,720	10,320	500	1,886	2,066	1,550	817	1,333	516
13	.....	.....	.....	.....	1,049	1,586	713	.....	.....	.....
14	3,440	2,600	4,640	262	1,534	1,936	1,198	456	1,194	738
15	2,240	1,400	2,240	136	1,452	1,738	1,116	345	967	622
16	.....	.....	.....	.....	1,136	1,435	800	.....	.....	.....
17	6,840	3,720	3,440	282	1,939	1,934	1,603	785	1,116	331
18	Manure,	232 tons	.....	?	1,815	1,955	1,479	642	1,118	476
19	.....	.....	.....	.....	1,191	1,458	855	.....	.....	.....
20	Manure,	116 tons	.....	?	1,640	1,760	1,304	431	887	456
21	6,840	3,700	†	282	1,982	1,864	1,646	755	973	218
22	.....	.....	.....	.....	1,245	1,545	909	.....	.....	.....
23	6,840	3,700	†	282	1,878	1,895	1,542	638	991	353
24	6,840	3,700	†	282	1,902	1,773	1,566	667	874	207
25	.....	.....	.....	.....	1,230	1,480	894	.....	.....	.....
26	‡	3,700	6,880	380	1,768	1,892	1,432	562	1,022	460
27	‡	.....	.....	.....	1,805	1,722	1,469	622	875	253
28	.....	.....	.....	.....	1,159	1,408	823	.....	.....	.....
29	‡	3,700	6,880	380	1,762	1,902	1,426	648	1,124	476
30	.....	3,700	†	282	1,767	1,809	1,431	699	1,077	378
31	.....	.....	.....	.....	1,023	1,482	687	.....	.....	.....
32	4,560	3,700	3,440	260	1,657	1,847	1,321	633	1,159	526
33	4,560	3,700	1,720	200	1,673	1,783	1,337	649	1,095	446
34	.....	.....	.....	.....	1,025	1,400	689	.....	.....	.....
35	4,560	1,850	6,880	334	1,718	1,917	1,382	693	1,228	535
36	4,560	925	6,880	311	1,657	1,948	1,321	632	1,259	627
37	.....	.....	.....	.....	1,025	1,490	689	.....	.....	.....
38	1,400	140	§	38	1,419	1,547	1,083	371	835	464
39	Manure,	232 tons	.....	?	1,675	1,754	1,339	604	1,019	415
40	.....	.....	.....	.....	1,094	1,254	758	.....	.....	.....
Average unfertilized yield.....					1,090	1,458	754	.....	.....	.....
Average increase from treatment...					.....	.....	.....	552	1,048	496**

*On wheat part of the nitrate of soda is replaced by dried blood, applied at time of seeding, the nitrate being added in the spring, but the whole is computed here as the equivalent of nitrate of soda. In 1912 the wheat was winter-killed and oats was grown instead; hence the fertilizing is computed as for 15 crops of corn and 14 crops each of oats and wheat

†Nitrogen in linseed oilmeal on Plot 21, in dried blood on Plot 23, in sulphate of ammonia on Plot 24, and in tankage on Plot 30, equivalent to that in nitrate of soda on Plot 17.

‡Phosphorus in steamed bonemeal on Plot 26, in dissolved boneblack on Plot 27, and in basic slag on Plot 29, equivalent to that in acid phosphate on Plot 11.

§Part of the phosphorus and all the nitrogen in tankage, the total equivalent to 2,940 pounds of a 2-8-2 fertilizer, all applied to wheat (210 pounds on each crop) and computed at $26 per ton.

**This increase is larger than that computed on page 271, because all the increased effect due to combination with carriers of nitrogen and potassium is here credited to the floats. (See page 255, lines 8 to 11.)

TABLE 42.—Liming experiment at Strongsville—Plan of treatment and average annual yield and increase from liming, 1906-1923

Block No.	Plot No.	Basic treatment	Liming (all on corn)	Corn—17 crops		Wheat—5 crops*		Oats—9 crops*		Hay 14 crops	Plot No.
				Grain Bu.	Stover Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Lb.	
				Average annual yield per acre							
I	1	Acid phosphate 160 lbs. On corn and oats	None	25.62	1,677	11.19	1,508	38.95	1,277	1,772	1
	2		1 ton every 3d year	36.88	2,125	15.76	1,660	54.88	1,783	2,557	2
	3		2 tons every 6th year	39.75	2,176	17.97	2,154	56.32	1,872	2,929	3
	4		3 tons every 9th year	41.74	2,192	17.16	2,174	56.61	1,835	3,002	4
	5		None	30.39	1,830	15.03	1,848	50.40	1,627	2,246	5
II	6	Acid phosphate 160 lb. Nitrate of soda 80 lb. On corn and oats	None	33.90	1,902	14.69	1,785	58.28	1,902	2,305	6
	7		1 ton every 3d year	40.65	2,233	14.77	1,973	62.20	2,099	2,716	7
	8		2 tons every 6th year	43.44	2,322	16.48	2,130	62.29	2,134	2,945	8
	9		3 tons every 9th year	44.17	2,359	17.83	2,195	64.76	2,214	2,947	9
	10		None	34.66	2,020	16.03	1,852	60.04	1,919	2,527	10
III	11	Acid phosphate 160 lb. Nitrate of soda 80 lb. Muriate potash 80 lb. On corn and oats	None	30.65	2,015	14.68	1,807	60.31	2,038	2,280	11
	12		1 ton every 3d year	40.07	2,335	14.86	1,918	64.25	2,156	2,668	12
	13		2 tons every 6th year	41.66	2,331	15.59	2,066	65.06	2,118	2,824	13
	14		3 tons every 9th year	41.22	2,372	16.60	2,132	63.30	2,167	2,887	14
	15		None	30.09	2,023	16.71	1,769	59.16	1,907	2,301	15
IV	16	Acid phosphate 160 lb. Nitrate of soda 80 lb. Muriate of potash 80 On corn and oats	None	30.36	2,022	16.06	1,732	60.68	1,960	2,287	16
	17		2 tons every 3d year	47.92	2,540	18.99	2,364	66.14	2,194	3,080	17
	18		4 tons every 6th year	47.07	2,633	18.40	2,422	65.33	2,297	3,313	18
	19		6 tons every 9th year	44.43	2,462	19.35	2,413	63.28	2,192	3,284	19
	20		None	33.75	2,293	16.88	1,990	61.51	2,093	2,524	20
V	21	Acid phosphate 160 lb. On corn and oats Manure 8 tons On corn only	None	41.73	2,534	17.15	1,918	57.97	1,940	2,740	21
	22		1 ton every 3d year	51.10	2,839	15.96	2,100	60.85	2,148	3,256	22
	23		3 tons every 6th year	51.79	2,923	17.79	2,273	61.91	2,200	3,670	23
	24		6 tons every 9th year	51.57	2,926	18.77	2,242	60.76	2,151	3,846	24
	25		None	46.55	2,747	15.57	1,995	56.84	1,930	3,165	25
VI	26	Manure 8 tons On corn only	None	37.88	2,461	9.11	1,213	49.32	1,703	2,198	26
	27		1 ton every 3d year	44.88	2,621	9.34	1,441	51.60	1,722	2,416	27
	28		3 tons every 6th year	49.46	2,765	11.19	1,619	55.66	1,887	3,017	28
	29		6 tons every 9th year	47.78	2,712	12.50	1,799	53.37	1,917	3,136	29
	30		None	33.20	2,218	5.97	880	42.78	1,512	2,126	30

*Wheat previous to 1915, oats since.

TABLE 42.—Liming experiment at Strongsville—Plan of treatment and average annual yield and increase from liming, 1906-1923—Continued

Block No.	Plot No.	Basic treatment	Liming (all on corn)	Corn—17 crops		Wheat—5 crops*		Oats—9 crops		Hay 14 crops	Plot No.
				Grain Bu.	Stover Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Lb.	
			Average annual increase per acre for liming								
I	2	Acid phosphate	1 ton every 3d year....	10.07	410	3.61	67	13.07	418	667	2
	3		2 tons every 6th year....	11.75	413	4.86	476	11.65	420	921	3
	4		3 tons every 9th year....	12.54	400	3.08	411	9.07	295	874	4
II	7	Acid phosphate Nitrate of soda	1 ton every 3d year....	6.56	302	—0.25	171	3.49	193	355	7
	8		2 tons every 6th year....	9.16	361	1.07	312	3.13	224	529	8
	9		3 tons every 9th year....	9.70	367	2.14	361	5.17	299	476	9
III	12	Acid phosphate Nitrate of soda Muriate of potash	1 ton every 3d year....	9.57	318	—0.33	120	4.23	152	383	12
	13		2 tons every 6th year....	11.29	313	—0.10	278	5.32	146	533	13
	14		3 tons every 9th year....	10.98	351	0.40	354	3.85	227	591	14
IV	17	Acid phosphate Nitrate of soda Muriate of potash	2 tons every 3d year....	16.71	450	2.73	567	5.26	202	733	17
	18		4 tons every 6th year....	15.01	475	1.93	560	4.24	271	908	18
	19		6 tons every 9th year....	11.54	236	2.67	487	1.98	132	820	19
V	22	Acid phosphate Manure	1 ton every 3d year....	8.17	252	—0.80	162	3.16	211	410	22
	23		3 tons every 6th year....	7.66	282	1.43	317	4.50	265	716	23
	24		6 tons every 9th year....	6.22	232	2.81	269	3.64	218	786	24
VI	27	Manure	1 ton every 3d year...	8.17	221	1.03	311	3.91	67	236	27
	28		3 tons every 6th year....	13.92	426	3.64	572	9.61	280	855	28
	29		6 tons every 9th year....	13.41	434	5.74	835	8.97	357	991	29

*Wheat previous to 1915, oats since.

TABLE 43.—Liming Strongsville land—Total fertilizers, lime, and manure applied; total value of crops harvested, and value of increase for liming for entire period of 17 years—All per acre

Block No.	Plot No.	Basic treatment		Lime-stone	Value of total produce	Value of increase for liming
				Tons	*Dollars*	*Dollars*
I	1			.....	802	.....
	2			17	1,131	283
	3	Acid phosphate	5,440 pounds	16	1,229	335
	4			15	1,258	317
	5			.....	987	.....
II	6			.....	1,070	.....
	7	Acid phosphate	5,440 pounds	17	1,229	146
	8			16	1,300	204
	9	Nitrate of soda	2,720 pounds	15	1,329	220
	10			.....	1,122	.....
III	11			.....	1,044	.....
	12	Acid phosphate	5,440 pounds	17	1,230	186
	13	Nitrate of soda	2,720 pounds	16	1,272	228
	14	Muriate of potash	2,720 pounds	15	1,275	232
	15			.....	1,043	.....
IV	16			.....	1,047	.....
	17	Acid phosphate	5,440 pounds	34	1,408	338
	18	Nitrate of soda	2,720 pounds	32	1,423	331
	19	Muriate of potash	2,720 pounds	30	1,376	262
	20			.....	1,137	.....
V	21			.....	1,249	.....
	22	Acid phosphate	5,440 pounds	17	1,439	165
	23			24	1,510	211
	24	Yard manure	136 tons	30	1,525	201
	25			.....	1,349	.....
VI	26			.....	1,060	.....
	27			17	1,185	155
	28	Yard manure	136 tons	24	1,338	338
	29			30	1,329	359
	30			.....	940	.....

APPROXIMATE EFFECT OF MANURE AND FERTILIZERS

	Dollars
Product of land receiving manure only (Plots 26 and 30)	1,000
Product for manure and acid phosphate (Plots 21 and 25)	1,299
Increase for acid phosphate	299
Product of land receiving acid phosphate only (Plots 1 and 5)	894
Estimated increase due to acid phosphate	299
Approximate unaided yield of land	595
Product of land receiving manure only (Plots 26 and 30)	1,000
Estimated unaided yield of land	595
Approximate increase for manure	405
Product of land receiving acid phosphate only (Plots 1 and 5)	894
Product of land receiving acid phosphate and nitrate of soda (Plots 6 and 10)	1,096
Approximate increase for nitrate of soda	202

TABLE 44.—TOBACCO, WHEAT, AND CLOVER grown in 3-year rotation at Germantown
Average annual yield per acre by periods

Plot No.	Fertilizing materials per acre (All applied to the tobacco crop)	Tobacco			Wheat						Clover		
		21 years 1903-23	12 years 1903-14	9 years 1915-23	20 years—1904-23		12 years—1904-15		8 years—1916-23		18 years 1905-23	12 years 1905-16	6 years 1917-23*
					Grain	Straw	Grain	Straw	Grain	Straw			
		Lb.	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1	None	578	615	528	11.53	1,514	12.20	1,490	10.54	1,550	2,414	2,670	1,904
2	Acid phosphate, 480 lb	778	907	607	21.96	2,758	20.86	2,572	23.61	3,036	3,404	3,784	2,645
3	Acid phosphate, 480 lb.; muriate potash, 180 lb	1,125	1,226	991	25.24	3,033	23.80	2,774	27.40	3,421	3,807	4,245	2,932
4	None	537	603	449	11.90	1,519	12.65	1,545	10.79	1,479	2,267	2,594	1,614
5	Muriate potash, 180 lb.; nitrate soda, 240 lb	759	852	634	15.83	1,937	17.20	1,950	13.78	1,918	2,826	3,216	2,045
6	Acid phosphate, 480 lb.; nitrate soda, 240 lb	1,009	1,147	824	25.19	3,122	25.17	2,946	25.21	3,385	3,688	4,185	2,693
7	None	612	672	533	12.91	1,651	13.40	1,656	12.18	1,644	2,508	2,873	1,779
8	Acid phos., 480 lb.; mur. potash, 180 lb.; nit. soda, 240 lb	1,231	1,352	1,069	26.22	3,262	26.18	3,149	26.28	3,431	3,793	4,268	2,844
9	Acid phos., 480 lb.; mur. potash, 300 lb.; nit. soda, 240 lb	1,227	1,334	1,085	26.97	3,182	27.30	2,978	26.47	3,490	3,903	4,362	2,986
10	None	551	612	470	11.47	1,461	11.49	1,450	11.44	1,479	2,193	2,510	1,560
11	None	519	572	449	11.43	1,515	11.83	1,522	10.83	1,505	2,508	2,830	1,864
12	Acid phos., 480 lb.; mur. potash, 120 lb.; nit. soda, 240 lb	1,164	1,217	1,092	24.75	3,128	23.78	2,951	26.21	3,392	3,686	4,103	2,852
13	Acid phos., 720 lb.; mur. potash, 180 lb.; nit. soda, 240 lb	1,286	1,363	1,184	28.01	3,324	27.83	3,192	28.28	3,523	4,129	4,658	3,070
14	None	531	571	478	11.78	1,580	12.22	1,502	11.12	1,697	2,417	2,751	1,749
15	Acid phos., 480 lb.; mur. potash, 180 lb.; nit. soda, 360 lb	1,222	1,294	1,125	26.25	3,299	26.53	3,206	25.82	3,438	3,637	4,195	2,521
16	Acid phos., 480 lb.; mur. potash, 180 lb.; sulph. ammonia, 180 lb	1,117	1,220	981	25.33	3,060	24.60	2,864	26.41	3,355	3,559	4,017	2,641
17	None	459	512	388	11.31	1,478	11.37	1,401	11.23	1,594	2,375	2,681	1,762
18	Acid phos., 60 lb.; tankage (7-20) 670 lb.; muriate potash, 180 lb	996	1,041	935	25.58	2,960	24.48	2,728	27.23	3,309	3,744	4,223	2,785
19	Acid phos., 320 lb.; mur. potash, 180 lb.; nit. soda, 240 lb	1,059	1,130	965	24.48	2,880	24.28	2,659	24.78	3,213	3,449	3,934	2,478
20	None	458	513	383	10.14	1,370	9.86	1,287	10.56	1,494	2,284	2,658	1,538

*Clover failed in 1920.

TABLE 44.—TOBACCO, WHEAT, AND CLOVER grown in 3-year rotation at Germantown
Average annual yield per acre by periods—Continued

Plot No.	Fertilizing materials per acre (All applied to the tobacco crop)	Tobacco			Wheat						Clover		
		21 years 1903-23	12 years 1903-14	9 years 1915-23	20 years—1904-23		12 years—1904-15		8 years—1916-23		18 years 1905-23	12 years 1905-16	6 years 1917-23*
					Grain	Straw	Grain	Straw	Grain	Straw			
		Lb.	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
21	None	527	583	452	10.59	1,367	10.65	1,333	10.50	1,417	2,221	2,490	1,684
22	Acid phos., 480 lb.; nitrate potash, 200 lb.; nit. soda, 80 lb	1,134	1,204	1,040	24.15	2,999	23.63	2,790	24.93	3,312	3,492	3,779	2,920
23	Acid phos., 480 lb.; sulphate potash, 190 lb.; nit. soda, 240 lb.	1,133	1,213	1,025	24.52	3,035	23.70	2,816	25.74	3,363	3,591	3,923	2,930
24	None	523	577	452	10.46	1,398	10.48	1,296	10.42	1,550	2,019	2,264	1,524
25	Acid phos., 480 lb.; sul. pot., 190 lb.; nit. soda, 240 lb.; lime, 1,000 lb.	1,082	1,175	957	25.22	3,226	24.61	2,905	26.12	3,707	3,656	3,865	3,237
26	Acid phos., 480 lb.; mur. pot., 180 lb.; nit. soda, 240 lb.; lime, 1,000 lb.	1,092	1,200	947	27.11	3,365	26.02	3,035	28.74	3,861	3,722	3,990	3,185
27	None	458	528	364	10.77	1,338	11.14	1,255	10.21	1,462	2,001	2,161	1,682
28	Acid phos., 480 lb.; mur. pot., 180 lb.; sul. am., 180 lb.; lime, 1,000 lb.	1,090	1,209	932	27.61	3,336	26.51	3,065	29.25	3,742	3,767	4,006	3,289
29	Acid phos., 60 lb.; tank., (7-20) 670 lb., mur. pot., 180 lb.; lime, 1,000 lb	987	1,057	893	24.11	2,811	21.78	2,460	27.61	3,338	3,677	3,907	3,219
30	None	459	514	386	10.41	1,370	10.50	1,315	10.28	1,453	2,060	2,333	1,512
31	None	538	566	500	10.26	1,322	9.77	1,250	11.01	1,429	1,882	2,192	1,261
32	Shed manure, untreated, 10 tons	1,048	1,049	1,046	21.80	2,789	22.14	2,633	21.29	3,022	3,167	3,490	2,523
33	Shed manure, untreated, 20 tons	1,181	1,189	1,171	26.23	3,427	26.84	3,256	25.32	3,683	3,685	3,999	3,057
34	None	518	520	515	10.22	1,412	9.65	1,313	11.08	1,560	1,939	2,182	1,453
35	Shed manure, phosphated, 10 tons	1,128	1,095	1,172	26.23	3,261	24.93	2,879	28.18	3,834	3,877	4,083	3,465
36	Yard manure, phosphated, 10 tons	951	964	933	24.10	2,952	23.06	2,655	25.67	3,397	3,333	3,622	2,756
37	None	462	485	432	9.81	1,253	10.07	1,221	9.43	1,301	2,030	2,228	1,634
38	Shed manure, untreated, 10 tons; lime, 1,000 lb	982	977	888	23.76	3,013	23.61	2,746	23.99	3,413	3,429	3,502	3,283
39	Yard manure, untreated, 10 tons; lime, 1,000 lb	803	821	780	20.05	2,457	19.04	2,243	21.57	2,778	3,053	3,179	2,799
40	None	425	459	379	9.19	1,196	8.77	1,161	9.82	1,248	1,626	1,797	1,287
O	Average unfertilized yield	510	550	447	10.89	1,421	11.00	1,375	10.71	1,491	2,149	2,377	1,694

*Clover failed in 1920.

TABLE 45.—TOBACCO, WHEAT, AND CLOVER grown in rotation at Germantown
Average annual increase per acre by periods

Plot	Tobacco			Wheat						Clover			Plot
	21 years 1903–1923	12 years 1903–1914	9 years 1915–1923	20 years—1904–1923		12 years—1904–1915		8 years—1916–1923		18 years 1905–1923	12 years 1905–1916	6 years 1917–1923	
				Grain	Straw	Grain	Straw	Grain	Straw				
No.	*Lb.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*No.*
2	214	296	105	10.30	1,242	8.51	1,062	12.99	1,509	1,039	1,139	838	2
3	574	619	515	13.46	1,516	11.32	1,247	16.69	1,919	1,490	1,625	1,221	3
5	197	226	158	3.59	375	4.29	368	2.53	384	478	530	376	5
6	422	498	320	12.61	1,515	12.02	1,327	13.49	1,796	1,260	1,405	968	6
8	639	700	557	13.79	1,674	13.42	1,562	14.35	1,842	1,390	1,516	1,138	8
9	655	702	592	15.02	1,658	15.17	1,460	14.79	1,955	1,605	1,730	1,353	9
12	641	646	634	13.20	1,591	11.82	1,436	15.28	1,823	1,209	1,300	1,026	12
13	759	790	716	16.35	1,766	15.74	1,680	17.26	1,890	1,681	1,881	1,282	13
15	714	742	677	14.62	1,753	14.60	1,738	14.66	1,775	1,234	1,469	767	15
16	634	688	562	13.86	1,549	12.95	1,429	15.22	1,728	1,170	1,313	883	16
18	537	528	549	14.65	1,518	13.61	1,365	16.22	1,738	1,399	1,550	1,098	18
19	601	617	580	13.95	1,475	13.92	1,334	14.00	1,686	1,134	1,268	865	19
22	608	622	589	13.61	1,622	13.04	1,470	14.45	1,850	1,339	1,364	1,289	22
23	608	634	574	14.01	1,647	13.16	1,508	15.30	1,857	1,506	1,583	1,352	23
25	580	615	534	14.65	1,848	13.91	1,623	15.78	2,187	1,643	1,635	1,660	25
26	612	656	553	16.44	2,007	15.10	1,766	18.46	2,360	1,715	1,795	1,556	26
28	632	686	561	16.96	1,987	15.58	1,790	19.02	2,283	1,746	1,787	1,664	28
29	528	538	515	13.58	1,452	11.07	1,163	17.36	1,882	1,638	1,631	1,651	29
32	517	498	541	11.55	1,437	12.41	1,362	10.26	1,550	1,266	1,300	1,198	32
33	657	653	661	15.99	2,045	17.15	1,964	14.26	2,167	1,764	1,813	1,667	33
35	629	587	685	16.14	1,902	15.14	1,597	17.64	2,361	1,908	1,886	1,951	35
36	470	467	473	14.15	1,646	13.14	1,403	15.69	2,010	1,334	1,409	1,182	36
38	532	500	573	14.15	1,779	13.97	1,544	14.43	2,130	1,533	1,418	1,764	38
39	366	353	383	10.65	1,242	9.83	1,061	11.83	1,512	1,291	1,239	1,396	39

TABLE 46.—TOBACCO, WHEAT, AND CLOVER grown in rotation at Germantown
Fertilizing constituents, total and net values of increase, all per acre per rotation

Plot	Fertilizing constituents			Cost of fertilizers	Total value of increase			Net value of increase			Plot
	Ammonia	Phosphoric acid	Potash		21 years 1903-23	First period	Last period	21 years 1903-23	First period	Last period	
No.	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*No.*
2	.....	70	.....	4.80	31.90	34.48	28.30	27.10	29.68	23.50	2
3	.....	70	90	9.30	57.12	57.55	56 40	47.82	48.25	47.10	3
5	45	.....	90	12.90	17.96	20.48	14.21	5.06	7.58	1.31	5
6	45	70	.....	13.20	46.95	50.76	41.24	33.75	37.56	28.04	6
8	45	70	90	17.70	60.34	63.70	55.33	42.64	46.00	37.63	8
9	45	70	150	20.20	63.94	66.90	59.42	43.74	46.70	39.22	9
12	45	70	60	16.20	58.29	57.45	59.24	42.09	41.25	43.04	12
13	45	105	90	20.10	71.31	73 51	67.40	51.21	53.41	47.30	13
15	67	70	90	21.90	63.95	67.05	58.70	42.05	45.15	36.80	15
16	a45	70	90	17.70	58.20	60.76	54.26	40.50	43.06	36.56	16
18	b45	70	90	17.70	55.79	55.04	56.25	38.09	37.34	38.55	18
19	45	45	90	16.10	56.19	57.61	53.70	40.09	41.51	37.60	19
22	45	70	c90	17.70	58.10	58.04	58.18	40.40	40.34	40.48	22
23	45	70	d90	17.70	59.82	60.50	58.78	42.12	42.80	41.08	23
25*	45	70	d90	22.70	60.58	60.98	60.40	37.88	38.28	37.70	25*
26*	45	70	90	22.70	64.91	65.76	63.70	42.21	43.06	41.00	26*
28*	a45	70	90	22.70	66.62	67.74	65.26	43.92	45.04	42.56	28*
29*	b45	70	90	22.70	55.90	57.61	60.20	33.20	34.91	37.50	29*
32	100	50	100	e	50.48	50.46	50.17	.....	.....	.....	32
33	200	100	200	e	67.18	68.30	65.23	.....	.....	.....	33
35	100	100	100	e	66.65	62.62	72.41	....	.....	.....	35
36	70	90	60	e	51.76	50.55	53.22	.....	.....	.....	36
38*	100	50	100	e	56.69	53.45	61.63	.....	.....	.....	38*
39*	70	40	60	e	41.73	39.42	45.23	.....	.....	.....	39*

*Limed.

a In sulphate ammonia. b In tankage. c In nitrate potash. d In sulphate potash. e See Table 44.

TABLE 47.—Tobacco grown continuously at Germantown

Plot	Annual treatment per acre							Average yield and increase per acre				Percentage recovery of fertilizing constituents last 5 years			Financial outcome last 5 years			Plot
	Fertilizing materials				Fertilizing constituents			21 years 1903-1923		5 years 1919-1923								
	Nitrate of soda	Acid phosphate	Muriate of potash	Untreated shed manure	Nitrogen	Phosphoric acid	Potash	Yield	Increase	Yield	Increase	Nitrogen	Phosphoric acid	Potash	Value of increase	Cost of treatment	Balance	
No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Pct.*	*Pct.*	*Pct.*	*Dol.*	*Dol.*	*Dol.*	*No.*
1	.....	.....	.....	.....	.....	.....	.....	310	.....	241	.....	.....	.....	.....	.....	.....	.....	1
2	80	160	60	.....	12.5	23	30	681	348	638	351	100	10	64	17.55	5.85	11.70	2
3	160	160	60	.....	25	23	30	778	422	749	416	60	11	76	20.80	8.60	12.20	3
4	.....	.....	.....	.....	.....	.....	.....	379	.....	379	.....	.....	.....	.....	.....	.....	.....	4
5	320	160	60	.....	50	23	30	909	547	887	521	39	13	95	26.05	14.10	11.95	5
6	480	160	60	.....	75	23	30	879	534	843	489	24	13	89	24.45	19.60	4.85	6
7	.....	.....	.....	.....	.....	.....	.....	329	.....	341	.....	.....	.....	.....	.....	.....	.....	7
8	320	320	60	.....	50	46	30	1,004	681	966	626	46	9	115	31.30	15.70	15.60	8
9	320	320	120	.....	50	46	60	1,051	733	1,008	668	49	9	61	33.40	16.20	17.20	9
10	.....	.....	.....	.....	.....	.....	.....	312	.....	339	.....	.....	.....	.....	.....	.....	.....	10
Average unfertilized yield								333	.....	325	.....	.....	.....	.....	.....	.....	.....	
11	.....	.....	.....	8	80	40	80	843	510	963	638	30	9	44	31.90	24.40	7.50	11
12	.....	160	.....	8	80	63	80	989	656	1,145	820	38	8	56	41.00	26.00	15.00	12
13	160	160	60	8	92	63	110	1,131	798	1,259	934	37	9	47	46.70	30.15	16.55	13
14	.....	.....	.....	8	80	40	80	867	534	1,008	683	44	10	47	34.15	24.40	9.75	14
15	320	160	60	8	105	63	110	1,174	841	1,269	944	34	9	47	47.20	33.00	14.20	15
16	†	†	†	8	130	65	130	1,220	887	1,313	988	28	9	42	49.40	39.65	9.85	16
17	.....	.....	.....	8	80	40	80	1,024	691	1,116	791	27	12	54	39.55	24.40	15.15	17
18	‡	‡	‡	8	110	55	100	1,179	846	1,260	935	31	10	51	46.75	33.05	13.70	18

†Phosphated shed manure, 40 pounds acid phosphate per ton of manure.
‡Phosphated yard manure, 40 pounds acid phosphate per ton of manure.

TABLE 48.—Plan of fertilizing in Corn-Wheat-Clover rotation at Germantown

Plot No.	Fertilizing materials. Pounds per acre each on corn and wheat, except as stated
1	Unfertilized
2	Acid phosphate, 120 lb.
3	Acid phosphate, 120 lb., muriate of potash, 20 lb.
4	Unfertilized
5	Muriate of potash, 20 lb.; nitrate of soda, 80 lb.*
6	Acid phosphate, 120 lb.; nitrate of soda, 80 lb.
7	Unfertilized
8	Acid phosphate, 120 lb.; muriate of potash, 20 lb.; nitrate of soda, 80 lb.
9	Acid phosphate, 120 lb.; muriate of potash, 20 lb.; nitrate of soda, 160 lb.
10	Unfertilized
11	Acid phosphate, 120 lb.; muriate of potash, 40 lb.; nitrate of soda, 160 lb.
12	Acid phosphate, 240 lb.; muriate of potash, 20 lb.; nitrate of soda, 80 lb.
13	Unfertilized
14	Acid phosphate, 240 lb.; muriate of potash, 40 lb.; nitrate of soda, 160 lb.
15	Acid phosphate, 480 lb.; muriate of potash, 80 lb.; nitrate of soda, 320 lb. (All on corn, limestone on wheat)†
16	Unfertilized
17	Untreated shed manure 5 tons on corn; limestone 1,000 lb. on wheat
18	Untreated shed manure 10 tons, 1904-5-6; limestone 1,000 lb., 1907-8-9; manure and limestone on corn only‡
19	Unfertilized
20	Untreated shed manure 10 tons, 1903-4-5; limestone 1,000 lb., 1906-7-8; manure and limestone on wheat only‡
21	Limestone 1,000 lb. on corn; untreated shed manure, 5 tons on wheat
22	Unfertilized
23	Untreated yard manure, 5 tons, on corn only
24	Untreated shed manure, 5 tons, on corn only
25	Unfertilized
26	Phosphated yard manure, 5 tons, on corn only§
27	Phosphated shed manure, 5 tons, on corn only§
28	Unfertilized
29	Phosphated shed manure, 5 tons on corn;§ limestone, 1,000 lb. on wheat
30	Tankage, 680 lb.; muriate of potash, 80 lb.; nitrate of soda, 80 lb. on corn; limestone, 1,000 lb. on wheat
31	Unfertilized
32	Tankage, 340 lb.; muriate of potash, 40 lb.; nitrate of soda, 40 lb.
33	Tankage, 340 lb.; muriate of potash, 60 lb.; nitrate of soda, 120 lb.
34	Unfertilized
35	Tankage, 220 lb.; acid phosphate, 200 lb.; muriate of potash, 20 lb.
36	Tankage, 220 lb.; acid phosphate, 200 lb.; muriate of potash, 40 lb.; nitrate of soda, 80 lb.
37	Unfertilized
38	Tankage, 500 lb.; muriate of potash, 60 lb.; nitrate of soda, 60 lb.
39	Tankage, 170 lb.; nitrate of soda, 18 lb.
40	Unfertilized

*On wheat one-fourth of the nitrogen is given in dried blood in the fall and the remainder in nitrate of soda in the spring, all computed as equivalent to the nitrate of soda used on the corn. Where tankage is used the nitrate of soda is all given to wheat in the spring.

†Lime was used in all cases as 1,000 pounds burnt or hydrated lime at first, later as 1,000 pounds ground limestone.

‡The use of lime and manure on alternate rotations has been continued.

§Forty pounds acid phosphate per ton of manure.

TABLE 49.—Corn, wheat, clover rotation at Germantown
Fertilizing constituents and yield and increase per acre per annum

Plot	Fertilizing constituents				Annual cost of fertilizers	Corn—20 years				Wheat—17 crops				Clover 19 years		Annual value of produce	Annual value of increase	Balance over cost of fertilizer	Plot
						Grain		Stover		Grain		Straw							
	Ammonia	Phosphoric acid	Potash	Lime		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase				
No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*No.*
1						35.45		1,893		9.20		1,146		1,861		18.52			1
2		12			0.85	43.36	6.92	2,208	283	15.61	6.04	1,807	601	2,489	613	24.89	5.90	5.05	2
3		12	7		1.20	50.14	12.72	2,520	564	17.87	7.94	1,999	733	2,633	742	28.00	8.55	7.35	3
4						38.39		1,988		10.30		1,326		1,907		19.92			4
5	10		7		2.20	43.51	5.50	2,203	223	11.52	1.54	1,408	128	2,009	122	22.02	2.39	.19	5
6	10	12			2.70	45.30	7.67	2,340	369	17.96	8.32	2,268	1,033	2,518	652	26.69	7.36	4.66	6
7						37.25		1,962		9.33		1,190		1,846		19.04			7
8	10	12	7		3.05	51.84	14.24	2,553	571	20.10	10.60	2,372	1,151	2,539	683	29.25	10.00	6.95	8
9	20	12	7		4.90	52.00	14.04	2,574	572	20.04	10.38	2,508	1,257	2,551	685	29.43	9.97	5.07	9
10						38.32		2,021		9.83		1,281		1,876		19.66			10
11	20	12	13		5.20	58.00	17.47	2,920	787	21.99	11.75	2,725	1,413	2,862	952	32.76	12.21	7.01	11
12	10	24	7		3.90	58.04	15.27	3,041	796	24.36	13.72	2,815	1,471	3,168	1,225	34.46	13.09	9.19	12
13						44.99		2,356		11.05		1,375		1,977		22.23			13
14	20	24	13		6.05	60.82	17.71	3,095	845	26.20	15.49	3,193	1,863	2,980	1,054	35.61	14.19	8.14	14
15	20	24	13	333	6.90	61.68	20.45	3,350	1,206	21.01	10.63	2,585	1,301	2,974	1,100	33.78	13.15	6.25	15
16						39.34		2,037		10.04		1,241		1,824		19.82			16
17	17	8	17	333	2.50	59.50	18.59	3,099	992	15.81	5.51	1,980	687	2,537	655	29.73	9.21	6.71	17
18	17	8	17	167	2.10	58.87	16.39	3,088	910	16.77	6.21	2,193	849	2,497	558	29.97	8.75	6.65	18
19						44.05		2,247		10.81		1,396		1,997		21.91			19
20	17	8	17	167	2.10	52.46	10.94	2,685	565	17.82	7.54	2,180	840	2,708	716	29.00	8.03	5.93	20

TABLE 49.—Corn, wheat, clover rotation at Germantown
Fertilizing constituents and yield and increase per acre per annum—Continued

Plot	Fertilizing constituents				Annual cost of fertilizers	Corn—20 years				Wheat—17 crops				Clover 19 years		Annual value of produce	Annual value of increase	Balance over cost of fertilizer	Plot
						Grain		Stover		Grain		Straw							
	Ammonia	Phosphoric acid	Potash	Lime		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase				
No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*No.*
21	17	8	17	333	2.50	49.69	10.71	2,464	472	18.35	8.60	2,272	986	2,937	949	29.00	8.95	6.45	21
22	.....	.....	.....	.....	.....	36.45	.....	1,865	.....	9.22	.....	1,230	.....	1,983	.....	19.11	.....	.....	22
23	12	6	10	.....	1.70	46.36	11.00	2,246	403	11.61	2.64	1,470	278	2,143	189	23.14	4.49	2.79	23
24	17	8	17	.....	1.70	52.07	17.80	2,531	709	13.69	4.97	1,741	586	2,312	388	26.05	7.86	6.16	24
25	.....	.....	.....	.....	.....	33.18	.....	1,800	.....	8.47	.....	1,116	.....	1,895	.....	17.73	.....	.....	25
26	12	16	10	.....	2.40	50.08	13.82	2,490	592	13.98	4.78	1,721	533	2,309	325	25.63	6.57	4.17	26
27	17	18	17	.....	2.40	57.45	18.10	2,913	917	16.94	7.00	1,996	737	2,510	437	29.42	9.03	6.63	27
28	.....	.....	.....	.....	.....	42.43	.....	2,094	.....	10.68	.....	1,330	.....	2,162	.....	21.72	.....	.....	28
29	17	18	17	333	3.20	60.45	18.64	3,298	1,211	18.80	8.18	2,377	1,003	2,942	772	32.46	10.85	7.65	29
30	20	24	13	333	6.90	57.86	16.69	3,080	1,000	19.16	8.61	2,427	1,010	3,132	954	32.31	10.82	3.92	30
31	.....	.....	.....	.....	.....	40.54	.....	2,073	.....	10.48	.....	1,460	.....	2,186	.....	21.36	.....	.....	31
32	20	24	13	.....	6.05	56.81	16.45	2,843	760	23.51	12.95	2,937	1,463	3,238	989	34.00	12.48	6.13	32
33	32	24	20	.....	8.60	55.10	14.91	2,991	899	24.28	13.63	3,138	1,652	3,263	951	34.21	12.52	3.92	33
34	.....	.....	.....	.....	.....	40.01	.....	2,102	.....	10.73	.....	1,500	.....	2,376	.....	21.85	.....	.....	34
35	10	33	7	.....	4.50	54.55	14.46	2,881	742	23.05	12.68	2,713	1,266	3,156	895	32.96	11.51	7.01	35
36	32	33	13	.....	8.90	54.48	14.33	2,941	765	24.41	14.40	3,009	1,616	3,124	975	33.62	12.56	3.46	36
37	.....	.....	.....	.....	.....	40.23	.....	2,212	.....	9.65	.....	1,339	.....	2,035	.....	20.65	.....	.....	37
38	32	33	20	.....	9.20	54.43	14.52	3,013	846	22.41	13.03	2,853	1,573	2,786	777	32.02	11.69	2.49	38
39	10	11	.....	.....	2.65	44.93	5.34	2,322	200	13.07	3.96	1,688	468	2,267	283	23.85	3.83	1.18	39
40	.....	.....	.....	.....	.....	39.27	.....	2,075	.....	8.84	.....	1,162	.....	1,957	.....	19.70	.....	.....	40
41	.....	.....	.....	333	.85	40.13	4.04	2,040	247	9.85	.60	1,307	212	3,089	636	23.16	3.11	2.26	41
Average unfertilized yield.....					.....	39.28	.....	2,052	.....	9.90	.....	1,292	.....	1,990	.....	20.23	.....	.....	

TABLE 50.—The CORN-WHEAT-CLOVER rotation at Carpenter—Average annual yield and increase per acre, 1904-1923

Plot	Corn—20 years				Wheat—19 years				Clover—19 years		Plot
	Grain		Stover		Grain		Straw		Hay		
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
No.	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*No.*
1	27.87	.....	1,501	.....	9.32	.....	954	.....	1,056	.....	1
2	34.73	8.41	1,657	217	15.50	6.29	1,450	542	1,331	279	2
3	35.39	10.62	1,727	348	17.05	7.95	1,665	803	1,499	450	3
4	23.22	.....	1,317	.....	8.98	.....	816	.....	1,044	.....	4
5	24.89	.50	1,432	62	10.33	1.09	966	96	1,105	—2	5
6	34.24	8.68	1,655	233	18.00	8.52	1,762	837	1,539	369	6
7	26.73	.....	1,474	.....	9.73	.....	981	.....	1,233	.....	7
8	39.76	14.12	1,848	430	19.83	10.70	1,924	1,025	1,790	614	8
9	38.15	13.61	1,810	447	19.27	10.73	2,032	1,214	1,686	569	9
10	23.44	.....	1,307	.....	7.94	.....	737	.....	1,058	.....	10
11	37.23	13.75	1,747	442	19.72	11.15	2,028	1,200	1,767	656	11
12	38.94	15.43	1,819	517	22.21	13.01	2,206	1,286	1,977	813	12
13	23.55	.....	1,301	.....	9.84	.....	1,010	.....	1,217	.....	13
14	43.08	19.41	1,926	629	24.69	15.08	2,512	1,541	2,327	1,141	14
15	44.91	21.11	2,048	753	21.41	12.03	2,209	1,278	2,729	1,584	15
16	23.93	.....	1,292	.....	9.14	.....	892	.....	1,110	.....	16
17	39.83	15.72	1,851	533	17.67	9.06	1,812	967	2,113	1,051	17
18	41.43	17.22	1,930	587	15.91	7.87	1,608	809	1,869	855	18
19	24.41	.....	1,369	.....	7.50	.....	753	.....	967	.....	19
20	35.42	11.06	1,763	395	17.67	10.16	1,786	1,033	2,379	1,412	20
	24.73	.....	1,366	.....	9.08	.....	877	.....	1,097	.....	

*Average unfertilized yields.

TABLE 51.—Corn, wheat, clover rotation at Carpenter and Germantown—Fertilizing constituents, value of increase, cost of treatment and balance, all computed per acre per annum

Plot	Fertilizing constituents				Cost of treatment	Value of increase		Balance		Plot
	Ammonia	Phosphoric acid	Potash	Limestone		Carpenter	Germantown	Carpenter	Germantown	
No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*No.*
2	.....	12	.....	.....	0.85	5.37	5.90	4.52	5.05	2
3	.....	12	7	.....	1 20	7.21	8.55	6.01	7.35	3
5	10	.....	7	.....	2.20	.61	2.39	—1.59	.19	5
6	10	12	.....	.....	2.70	6.68	7.36	3.98	4.66	6
8	10	12	7	.....	3.05	9.61	10.00	6.56	6.95	8
9	20	12	7	.....	4.90	9.56	9.97	4.66	5.07	9
11	20	12	13	.....	5.20	10.00	12.21	4.80	7.01	11
12	10	24	7	.....	3.90	11.47	13.09	7.57	9.19	12
14	20	24	13	.....	6.05	14.21	14.19	8.16	8.14	14
15	20	24	13	333	6.90	14.59	13.15	7.69	6.25	15
17	17*	8*	17*	333	2.50	10.56	9.21	8.06	6.71	17
18	17*	8*	17*	333	2.10	9 94	8.75	7.84	6.65	18
20	17*	8*	17*	333	2.10	10.69	8.03	8.59	5.93	20

*In manure.

TABLE 52.—The CORN-OATS-WHEAT-CLOVER rotation at Findlay
Plan of fertilizing

Fertilizing materials—pounds per acre

Plot No.	On corn				On oats			On wheat				Plot No.
	Acid phosphate	Muriate of potash	Nitrate of soda	Limestone	Acid phosphate	Muriate of potash	Nitrate of soda	Acid phosphate	Muriate of potash	Dried blood	Nitrate of soda	
1												1
2	120				120			120				2
3	120	20			120	20		120	20			3
4												4
5		20	40			20	40		20	30	60	5
6	120		40		120		40	120		30	60	6
7												7
8	120	20	40		120	20	40	120	20	30	60	8
9	120	20	40	2,000	120	20	40	120	20	30	60	9
10												10
11	*							*				11
12	*			2,000	120			120				12
13												13
14	120	*						120	*			14

*Untreated manure, 5 tons per acre.

TABLE 53.—Corn, oats, wheat, and clover in rotation at Findlay
Average yield and increase per acre

Plot No.	Corn—13 years		Oats—14 years		Wheat—13 years		Clover 10 years	Plot No.
	Grain Bu.	Stover Lb.	Grain Bu.	Straw Lb.	Grain Bu.	Straw Lb.	Lb.	
Yield								
1	24.34	1,755	26.01	1,446	5.26	794	1,567	1
2	31.27	2,015	31.27	1,811	10.69	1,462	2,215	2
3	35.67	2,338	31.74	1,807	12.41	1,516	2,449	3
4	28.58	1,982	20.70	1,416	6.27	1,051	1,586	4
5	37.42	2,403	31.85	1,707	10.54	1,478	2,576	5
6	42.29	2,579	35.62	2,065	13.79	1,741	2,708	6
7	33.07	2,338	30.78	1,681	8.56	1,207	2,115	7
8	39.92	2,588	34.78	1,901	13.86	1,743	2,790	8
9	42.05	2,533	35.94	2,051	14.85	1,844	3,084	9
10	30.67	2,190	30.24	1,529	7.76	1,089	1,872	10
11	47.73	2,401	37.21	2,042	17.27	2,325	3,416	11
12	48.80	2,855	40.22	2,227	14.74	1,965	3,369	12
13	32.08	2,285	31.00	1,519	6 91	953	1,657	13
14	47.52	2,852	39.02	2,207	20.90	2,346	4,150	14
O	29.75	2,095	29.15	1,518	6.95	1,025	1,739	O
Increase								
2	5.52	183	4.70	375	5.10	583	642	2
3	8.50	431	4.60	381	6.48	558	869	3
5	7.35	302	3.12	203	3.50	375	814	5
6	10.72	360	5.87	474	6.00	586	770	6
8	7.65	300	4.17	270	5.56	575	756	8
9	10.58	294	5.51	472	6.82	715	1,131	9
11	16.59	679	6.72	516	9.79	1,281	1,615	11
12	17.19	601	9.47	704	7.55	967	1,640	12
14	15.42	575	8.01	688	13.98	1,393	2,493	14

TABLE 54.—Corn, oats, wheat, clover in rotation at Findlay—Fertilizing constituents, cost of treatment, value of increase, and balance—All computed per acre per annum

Plot	Fertilizing constituents				Cost of treatment	Value of increase	Balance	Plot
	Ammonia	Phosphoric acid	Potash	Limestone				
No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*No.*
2	.....	13	.....	.....	0.90	4.62	3.72	2
3	.....	13	7.5	.....	1.30	6.05	4.75	3
5	7.5	.....	7.5	.....	1.80	4.55	2.75	5
6	7.5	13	.....	.....	2.30	6.29	3.99	6
8	7.5	13	7.5	.....	2.70	5.28	2.58	8
9	7.5	13	7.5	500	3.95	7.15	3.20	9
11	25*	13*	20*	.....	2.50	10.60	8.10	11
12	12†	15†	10*	500	3.10	10.34	7.24	12
14	25*	20‡	20*	.....	3.10	13.33	10.23	14

*All in manure. †40 percent in manure. ‡60 percent in manure.

SUMMARY

In Table 55 the attempt is made to arrive at an approximate estimate of the effect of the separate fertilizing elements on crops grown in rotation with clover on Ohio soils.

The table shows that on every crop and every soil except the ancient lake bed in Paulding County, and on the wheat crop on that soil, *acid phosphate* has been used with profit. Wheat gives in the average as many bushels of increase from acid phosphate as corn. It is true that in the Wayne and Cuyahoga tests wheat has received a larger dose than corn, and that it has had the advantage of following other crops that have been fertilized, but after making all allowance it seems that wheat is especially responsive to this element in the fertilizer.

With *potash*, however, the outcome is very different, wheat showing in almost every case fewer bushels of gain from the addition of the potash salt than corn.

In all of these rotations corn has been the first crop after clover, and hence the corn would be expected to profit less from *nitrogen* in the fertilizer than wheat. On the other hand, a crop of corn consumes nearly twice as much nitrogen as an equivalent crop of wheat, and we find comparatively little difference in the effect of this element in the two crops. It is evident, however, that the purchase of nitrogen for crops grown in rotation with clover is very likely to be a losing proposition.

Limestone has been used with large profit on every soil east of the Scioto River, and with uncertain results west of that boundary.

TABLE 55.—SUMMARY OF EXPERIMENTS with fertilizers to 1923

Soil type	County	Duration of test	Fertilizer added	Increase				Value of increase	Cost of fertilizer	Balance
				Corn	Oats or soybeans	Wheat	Hay			
		Years	Lb.	Bu.	Bu.	Bu.	Lb.	Dol.	Dol.	Dol.
Increase from acid phosphate alone										
Volusia	Wayne	30	64	6.87	8.91	7.85	792*	5.14	.64	4.50
	Cuyahoga	28	64	10.33	13.34	9.62	1,675*	7.90	.64	7.26
	Trumbull	8	125	6.74	7.50	12.50	958	7.61	1.25	6.36
	Mahoning	6	125	6.46	4.77	12.34	709	4.40	1.25	3.15
Dekalb	Meigs	20	80	8.41	.....	7.95	272	5.54	.80	4.74
	Washington	9	125	6.52	4.95†	6.04	414	5.68	1.25	4.43
	Belmont	7	150	6.28	.....	5.72	683	3.71	1.50	2.21
Miami	Montgomery	20	80	6.92	.....	7.94	613	5.89	.80	5.09
	Miami	13	125	10.75	7.58	14.92	530	7.48	1.25	6.23
	Hancock	13	90	5.52	4.70	6.48	642	4.49	.90	3.59
	Madison	5	80	6.01	.....	9.87	336	4.23	.80	3.43
Clermont	Hamilton	11	125	4.05	1.69†	8.61	335	4.50	1.25	3.25
	Clermont	10	125	6.65	2.10†	6.49	352	4.23	1.25	2.98
Fulton	Paulding	12	125	—.55	—2.70	3.05	322	.66	1.25	—.59
Increase from acid phosphate and muriate of potash over that from acid phosphate alone										
Volusia	Wayne	30	52	9.41	4.71	1.51	721†	3.44	1.30	2.12
	Cuyahoga	28	52	.20	.21	1.19	—385*	—.22	1.30	—1.58
	Trumbull	8	10	1.28	.69	1.21	—374	.02	.25	—.23
	Mahoning	6	10	2.80	5.05	7.13	126	3.67	.25	3.42
Dekalb	Meigs	20	13.3	2.21	.....	1.66	175	1.72	.34	1.38
	Washington	9	22.5	.91	—2.60†	.44	23	—.61	.56	—1.17
	Belmont	7	12	—4.20	.....	1.97	—229	—.66	.30	—.96
Miami	Montgomery	20	13.3	5.80	.....	1.90	129	2.66	.34	2.32
	Miami	13	22.5	3.46	2.15	4.08	324	2.84	.56	2.28
	Hancock	13	15	2.98	—.10	1.38	227	1.44	.38	1.06
	Madison	5	23	2.87	.....	2.19	219	1.67	.58	1.09
Clermont	Hamilton	11	22.5	7.58	.88†	.85	172	2.43	.56	1.87
	Clermont	10	22.5	9.83	1.35†	1.81	308	3.62	.56	3.06
Fulton	Paulding	12	22.5	—.75	2.65	1.43	—102	.45	.56	—.11
Increase from acid phosphate, muriate of potash, and nitrate of soda over that from acid phosphate and muriate of potash										
Volusia	Wayne	30	96	4.37	5.51	7.07	806*	4.22	3.36	.86
	Cuyahoga	28	96	3.01	3.64	2.80	246*	1.91	3.36	—1.45
	Trumbull	8	27.5	—.19	.33	.42	76	.27	.96	—.69
	Mahoning	6	27.5	2.39	.19	1.44	269	1.45	.96	.49
Dekalb	Meigs	20	53.3	3.50	.....	2.75	170	2.50	1.87	.63
	Washington	9	40	.39	.67†	3.18	182	1.67	1.40	.27
	Belmont	7	30	1.36	.....	1.31	504	1.63	1.05	.58
Miami	Montgomery	20	53.3	1.52	.....	2.66	—59	1.37	1.87	—.50
	Miami	13	40	—1.64	.20	.31	106	—.02	1.40	—1.42
	Hancock	13	40	—.85	—.43	—.92	—113	—.72	1.40	—2.12
	Madison	5	15	—1.43	.....	—.60	90	—.30	.53	—.83
Clermont	Hamilton	11	40	—.69	—.35†	1.34	124	.38	1.40	—1.02
	Clermont	10	40	3.09	.79†	5.21	288	3.09	1.40	1.69
Fulton	Paulding	12	40	2.97	3.08	3.22	—40	1.90	1.40	.50
Increase from complete fertilizer and limestone over that from fertilizer alone										
Volusia	Wayne	9	1,000	10.35	2.10	3.14	1,013*	5.20	2.50	2.70
	Cuyahoga	17	667	10.60	4.47	.....	502*	4.85	1.67	3.18
	Trumbull	8	1,000	9.31	5.45	4.48	419	4.73	2.50	2.23
Dekalb	Washington	6	500	4.70	3.80†	3.47	328	4.06	1.25	2.81
	Belmont	7	1,000	10.96	.....	3.65	2,400	7.83	2.50	5.33
Miami	Montgomery	20	333	5.21	.....	1.99	328	3.04	1.67	1.37
	Miami	13	1,000	.78	—.16	.71	286	1.10	2.50	—1.40
	Hancock	13	500	2.13	1.16	1.00	294	1.43	1.25	.18
Clermont	Hamilton	11	1,000	.43	—.66†	.26	397	.67	2.50	—1.83
	Clermont	10	1,000	2.36	1.52†	4.62	725	3.84	2.50	1.34
Fulton	Paulding	12	1,000	—1.98	—2.09	—.55	—185	—1.11	2.50	—3.67

*Two years—clover and timothy. †Soybeans.